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Contents

PAGE

The Use of the Motor Quotient in Assigning Relative Grades in Physical Education. *Theresa Anderson* 258
An Evaluation of Policies and Standards for Student Health Service Programs. *Rhea H. Williams* 262
Motor Learning of Feeble-Minded Girls. *D. K. Brace* 269
Change in Certification Requirements of Physical Education Teachers in 13 States Since 1942. *Laurence E. Morehouse and Alex D. Aloia* 276
Swimming Achievement Scale Scores for College Men. *Jack E. Hewitt* 282
A Note on Scaling Some Measures of Circulation and Respiration. *Leonard A. Larson* 290
The Measurement of the Strength of Muscle Relative to the Cross Section. *Carrie Belle Morris* 295
An Experiment in Teaching Tumbling With and Without Motion Pictures. *H. Steven Brown* and *Lloyd Messersmith* 304
Research Abstracts 308
Book Reviews 314
Index to Volume 19, 1948 316
Editorial Policies 320
Reprints from Past Issues 322
Life and Honorary Members 324
State, Section, and National Officers 327
Erratum 329

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The Use of the Motor Quotient in Assigning Relative Grades in Physical Education

By Theresa Anderson
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Des Moines, Iowa

(Submitted for publication June, 1948)

EVERY teacher faces a situation from time to time in which she finds girls with high motor quotients who do not put forth much effort and at the same time she finds girls with low motor quotients who put forth their utmost in effort. It has been suggested that grades relative to capacity would be worth while. It is possible that one might wish to give grades in physical education based upon something other than pure achievement. It is necessary in the academic field always to give achievement grades because society is set up that way. The student with low capacity who does the best work of which he is capable should be recognized.

PURPOSES OF THIS STUDY

The purposes of this study were to investigate the use of the motor quotient in assigning relative grades in physical education, and to determine the significance of effort upon these grades. By "relative grades"[1] is meant the grade in terms of achievement relative to existing motor ability plus ability to learn motor skills. Assuming that McCloy is correct in his contention that the motor quotient is a reasonably accurate measure of general motor capacity relative to size and maturity, then a girl who has a high motor quotient should be able, effort and experience being comparable, to reach a higher level of achievement than a girl with a low motor quotient. Obviously, however, even if experience and motor capacity were the same, girls who tried harder should reach higher levels of achievement than those who did not try as hard.

PROCEDURE

The subjects used in this study were 300 girls in grades ten, eleven, and twelve of North High School, Des Moines, Iowa. The age range was from fifteen to eighteen years inclusive. All were students of the investigator and all tests were administered under her direction. Only students engaged in the regular physical education class work were used. The group constituted a random sample of the girls in gymnasium classes in this school.

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1 C. H. McCloy. *Tests and Measurements in Health and Physical Education.* New York: F. S. Crofts and Co., 1942, pp. 300-301.

TABLE I

IDENTIFICATION OF VARIABLES

1. Original Grades (Ratings).
2. Original Grades Divided by Motor Quotient.
3. Motor Quotient.
4. Effort (Ratings).

ZERO ORDER CORRELATIONS

r_{12}	.765	r_{23}	.109
r_{13}	.494	r_{24}	.634
r_{14}	.572	r_{34}	.091

MULTIPLE CORRELATIONS COMPUTED

$R_{1.34}$	.725	$R_{2.13}$	.842
$R_{2.14}$	.798	$R_{2.134}$	.842

MISCELLANEOUS PARTIAL CORRELATIONS

$r_{13.2}$	.642	$r_{23.1}$	—.481
$r_{13.4}$	.541	$r_{24.1}$	.371
$r_{14.3}$	.610	$r_{34.1}$	—.270
$r_{21.3}$	.821	$r_{24.13}$	.295

Each girl was given a numerical grade in the various activities such as swimming, basketball, tumbling, volleyball, rope jumping, archery, golf, tennis, and calisthenics. They were graded according to McCloy's category scale[2]: 120, varsity caliber; 110, Superior; 100, Good, above average; 90, fair, about average; 80 poor, below average; 70, very poor. The grading was done individually by the investigator and her associate. The two teachers discussed their ratings and made adaptations suggested by the results of their discussions. Three weeks later, without reference to the first ratings, the procedure was repeated. The reliability of the ratings was found to be .903.

In addition to the ratings on sports achievements, a rating on effort was made as follows: 5—tries very hard; 4—tries reasonably hard; 3—about average; 2—does not try very hard; 1—does not try at all.

McCloy's test of general motor capacity was given to all the girls: Iowa Brace, Burpee, and Sargent. These were scored according to McCloy's scoring tables.[3]

The original numerical score for each girl was divided by her motor quotient. Putting these in terms of percentages, a grade was assigned each girl. A girl who is trying her best, but still is poor, might achieve as good a grade as a girl with a high motor quotient who did not try.

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2 McCloy, p. 302.

3 McCloy, pp. 357-359, Tables XXX, XXXI, XXXIV.

ANALYSIS OF DATA

Zero-order correlations were computed among the four variables. The correlation of .765 between the original grade and the original grade divided by the motor quotient would be expected because of the fact that the original grade is in both of them in the numerator. The correlation between the original grade and the motor quotient is only .494. Thus there is an overlap of about 49 percent.

In order to determine how much effort would raise that correlation (the correlation between effort and the original grade being .572) a multiple correlation for predicting original grade from motor quotient and effort was computed. The multiple correlation was .725. The difference between the .725 and 1.000 is probably unreliability of the tests due to fluctuations of day-to-day conditions, or due to lack of effort in trying the tests for the motor quotients, and reliability (.903) or shortcomings in the validity of the ratings. Possibly there are other elements concerned in the performance, such as insight into the skills, etc., which are not measured by the motor quotient.

A multiple correlation was computed to predict original grade, divided by motor quotient, from original grade and motor quotient, and this was .824. This is partly spurious because of the fact that the original grade is also in variable No. 2.

There are a few interesting observations here. When original grade and original grade divided by motor quotient are correlated, with motor quotient held constant, a correlation of —.481 is found. This negative correlation is obviously because of the fact that the motor quotient is in the denominator of one variable and in the numerator of the other.

Original grade and motor quotient with effort held constant gives a correlation of .541. With original grade and effort, with motor quotient held constant, the correlation is .610. In other words, the grade is based a little more on effort than it is on motor quotient. That is quite understandable in view of the fact that one can *see* effort, but one cannot "see" motor quotient in the same way; hence graders are apt to be lenient in grading those who try hard, in spite of making every effort to be perfectly objective. It is interesting to note from the original zero-order correlations, that there is very little relationship between motor quotient and effort (.091).

GENERAL CONCLUSIONS

The general conclusions follow quite well along the lines of the zero-order correlations and the multiple correlations (See Table I). The most significant correlation is probably the multiple corre-

lation $R_{1.34}$ where original grade is predicted from the motor quotient and effort. This would undoubtedly have been even higher if corrected for attenuation. As was stated above, the difference between the .725 and 1.000 is probably due to unreliability and lack of complete validity of the grade, and lack of completeness in the motor quotient as a measure of motor capacity. Thus the original grade can be predicted fairly well by motor quotient and effort alone (.725).

If we assume a reliability and validity of .85 for original grade, .90 for motor quotient, and .85 for effort (all reasonable assumptions), correct for attenuation and recompute the multiple correlation to predict original grade from motor quotient and effort, a multiple correlation of .838 is obtained.

As indicated by the zero-order correlations, as would be expected, there is very little relationship between motor quotient and effort.

The relationship between teachers' ratings of student classroom achievements and intelligence measurements is very much lower than this original correlation of .725, averaging about .50.

A recent study by McCloy and the investigator gave a correlation of .812 between the general motor capacity score and ratings of sports skills similar to the present study.[4] When a measurement of ability to distinguish spatial relationships was added, the multiple correlation rose to .854. It is therefore highly probable that if the ratings of original scores are very carefully done, if the general motor capacity tests are carefully administered, and if the general motor capacity variables are extended to take in more discriminating items, the correlation will be considerably higher.

It is therefore probable that the *relative grade*, obtained by dividing the original grade by a motor quotient which measures existing motor ability plus ability to learn motor skills plus effort, can become a very satisfactory grading device.

[4] Theresa Anderson and C. H. McCloy. The Measurement of Sports Ability in High School Girls. *Research Quarterly*, 18:1 (March, 1947), pp. 2-11.

An Evaluation of Policies and Standards for Student Health Service Programs

By Rhea H. Williams

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(Submitted for publication March, 1948)

PURPOSE

EVERY college has health service policies, and these policies affect the present and future welfare of all school personnel, teachers, and non-academic employees as well as students. The purpose of the evaluation of these policies is to present a clear, comprehensive, and definite statement of the consensus of well informed professional and administrative opinions concerning student health service programs. It is sometimes necessary to state policies in terms of the ideal program, practice, procedure, and personnel, and in this study all standards will be stated from that viewpoint. It is recognized that many colleges, especially small ones, do not have such facilities, finances, or personnel and will have to modify their practices accordingly. Nevertheless, it remains the best policy to carry out the better aspects of a health service program if at all possible. It is implied that the adoption of the essential policies as evaluated by this study in a college health service department will improve the health status of the students, the faculty, and the non-academic employees and the community in which they are located.

RELATED STUDIES

Although there exists an abundance of published material on the evaluation of standards and policies in the general field of health and physical education, there is little which is directly related to this study.

In his study Hughes (1) was concerned with determining and evaluating standards and policies in the administration of health and physical education for men in colleges and universities. In compiling his list of standards and policies to be submitted to the jurors for evaluation, he surveyed professional literature in health and physical education, interviewed outstanding authorities in the field, and visited outstanding health and education departments.

In 1935, DeWeese (2) gathered information relative to the

policies that were being utilized in the administration and organization of college hygiene. It consisted of a survey of all professional literature found in the *Proceedings* of the American Student Health Association over a period of fifteen years and listed some forty policies that had been in general usage.

Reporting for the President's Committee of Fifty on College Hygiene in 1927, Storey (3) secured his data from college catalogue announcements, personal visitations, and two questionnaires. In his summary and conclusions, suggested policies are given for the improvement of health services in institutions of higher learning in the United States. Brown (4) made a study of college and university health services in 1941. He was interested primarily in obtaining information on health service activities for the research committee of the American Student Health Association, and he studied only those colleges belonging to the association. The purpose in conducting this study was chiefly to detect any new trends, practices, or procedures that might be of interest and value to member schools.

In 1939, Diehl and Shephard (5) published the findings of a survey made for the American Youth Commission on the health of college students. Their data were secured by questionnaire and personal visits to 35 colleges with outstanding health service programs, and by a more detailed questionnaire to 646 presidents and directors of health services in colleges throughout the United States. The information derived was reported primarily for the purpose of assisting colleges to appraise their own student health services with the hope that the administration and operation of health programs would profit from the implications of this study.

METHODS OF EVALUATION

All phases of the experimental check list on the evaluation of policies were obtained from a combination of the following sources: personal interviews, previous studies, textbooks, periodicals, literature, pamphlets, bulletins, and letters from authorities in the field of health service. The original experimental check list consisted of 125 policies. As the present study did not intend to make a detailed evaluation of the policies in effect, it was decided to telescope them as much as possible but to maintain a representative sampling of the major policies of a health service program. On this basis the number of policies to be submitted for evaluation was reduced to fifty-two.

THE PRELIMINARY CHECK LIST AND QUESTIONNAIRE

After the experimental edition of the check list was compiled, the writer selected ten outstanding authorities in the fields of health and physical education, educational administration, health service, and

public health service to evaluate and study it carefully and offer recommendations for the final form. The authorities were divided as follows: three from health and physical education, three from health service, two from administration, and two from public health service. These men suggested a few minor changes in the policies, such as the rewording of five policies. Their greatest difficulty was in relation to wording the policies so that all of the final jurors would have the same thing in mind as they evaluated the policies.

The rating scale used on the check list provided for ratings from 1 to 4 which were titled "undesirable," "doubtful desirability," "desirable," and "absolutely essential," respectively. This scale makes for ease in rating and scoring the evaluations of policies relating to health service. Additional space was provided for jurors to add policies which they thought were essential but not included in the check list.

EVALUATION OF POLICIES FOR A STUDENT HEALTH SERVICE PROGRAM

The check list of policies to be evaluated was sent to 225 jurors. Check lists were sent to all 41 presidents and deans of Texas senior colleges; to the 35 directors of health and physical education in Texas colleges; to the 26 college physicians in Texas colleges; to 32 trustees and regents equally divided among large and small state colleges, and large and small private and denominational colleges; to 25 outstanding medical directors of health services in colleges outside of Texas; and to 25 outstanding authorities in the field of health and physical education in colleges outside of Texas. One hundred and sixty, or 71 percent, of the check lists were returned to the writer by the jurors. A breakdown according to the personnel divisions of the jurors gives the following number and percent of returns: Texas college presidents, 33, or 80 percent; Texas college deans, 32, or 76 percent; Texas college directors of health and physical education, 27, or 77 percent; Texas college trustees and regents, 17, or 53 percent; outstanding medical directors of health services in colleges outside of Texas, 14, or 60 percent; outstanding authorities in the field of health and physical education in colleges outside of Texas, 20, or 80 percent.

The return of 71 percent is far above the average return on such check lists and indicates a sincere interest in the problem by the jurors. This would appear to indicate that the check list was simple to administer, easy to check, and was stated in terminology that was readily understandable. The information was gathered over a period of twelve months and the data were tabulated on master sheets for the statistical application.

PRESENTATION OF DATA RELATIVE TO POLICIES

In the presentation of the data relative to the rating list on policies the author, after surveying the field of statistical literature, came to the conclusion that the simplest and most easily understood measure for interpreting these data would be the percent value. Since it is the consensus of the judges which will be used in finally locating the scale value of a policy, it was necessary to find some measure which best represented that consensus for each item. This the percent value does for each policy. This procedure has been used by several writers and authors in the evaluation and rating of various types of items. The percent value was determined as follows:

1. The values 1, 2, 3 and 4 were assigned to the ratings "undesirable," "doubtful desirability," "desirable," and "absolutely essential," in the order given.

2. The highest possible total weighted score, hereafter referred to as the highest possible score, for each policy was determined by multiplying the number of judges rating the policy by 4, the maximum possible value which could be assigned to that policy.

3. The actual total weighted score, hereafter referred to as the actual score, assigned each policy by the combined ratings of the jurors was then obtained. This was secured by multiplying the number of judges assigning a value to the policy by the scale value.

4. The percent value of each policy was obtained by dividing the actual score by the highest possible score. It will be noted that the highest possible score would be the same for all items in each respective category. If the actual score was 63 and the highest possible score, 75, the percent value of the item would be 84. Fractions of one-half of one percent or more were counted as whole numbers, and fractions of less than one-half of one percent were discarded in the computation of the percent scale value in this study.

This procedure of interpretation indicates the significance and importance placed on each particular policy by the judges and provides a semi-scientific method of interpreting evaluations, thus aiding in the selection of those policies which are essential to an efficient, functional health service department.

SUMMARY

In selecting policies to be recommended to administrators of college health services, the author found that any policy having a percentage value of 75 or higher was a policy which is advocated as an essential policy by most authorities in the field and is found in practice in most of the better college health service programs in the United States. Three of the policies which were rated slightly under 75 percent have been included as minimum essential policies

RANK OF POLICIES FOR HEALTH SERVICE IN ORDER OF HIGHEST POSSIBLE PERCENT VALUE BY ALL JURORS

Statement of Standard of Policy	*Combined Ratings of All Jurors*	
	*Percent***	*Rank*
Students should be clearly orientated as to the amount and type of health service available for their fee.	100	1.5
Parents should be notified immediately of any serious illness on the part of their children.	100	1.5
Student health records should always be treated as confidential, personal data by those using them.	97	3
Athletes should be examined by a physician approved by the health service prior to each sport season.	92	4
Every college should have an efficient, well planned, and organized modern health service program.	91	5
The health service fee should be compulsory for all students.	89	6
Students should be admitted to classes after an infectious illness only with a written certificate from the college health department.	88	7
The health service should be responsible for periodic inspections of buildings, rooming houses, and student eating establishments.	87	8
A physician should be present at each football game.	86	9
One full-time nurse should be available for every 1,000 students registered.	85	10
Freshmen and other new students should be required to have a health examination prior to registration.	84	12
The health service department should have a planned program for meeting student emergencies on or off the campus.	84	12
The health service program should be closely correlated to the program for athletics, physical training and professional preparation of teachers in health and physical education.	84	12
Each institution should have a full-time director of health service.	83	16
The director of health service should be a physician.	83	16
Each student should have an annual health examination.	83	16
Periodic reports should be made by the health service department to the proper authorities, e.g., president, dean, etc.	83	16
All teachers should be responsible for reporting immediately any signs of maladjustments in students.	83	16
The health examination of all new students should include an x-ray of the chest.	82	19
An individual conference with each person examined should be an essential part of the health examination.	81	22
Athletic coaches and trainers should work under the close supervision of the health service department.	81	22
The college physician should be invested with legal power for maintaining public health on the college campus.	81	22
The health service department should classify all students so as to distinguish those able to carry a normal academic load, those able to carry a normal physical education program, and those who need remedial training.	81	22
The program of the health service department should be coordinated with the services of the community health program.	81	22
The health of the student is the responsibility of the college.	79	27
All students should be immunized for smallpox, typhoid fever, and diphtheria before being allowed to register.	79	27
The director of the health service should have some training as an educator.	79	27

RANK OF POLICIES FOR HEALTH SERVICE IN ORDER OF HIGHEST POSSIBLE PERCENT VALUE BY ALL JURORS

Statement of Standard Policy	*Combined Ratings of All Jurors*	
	*Percent***	*Rank*
The college should arrange for infirmary services on the ratio of 10 beds for each 1,000 students registered.	79	27
Health service departments should prescribe corrective exercises for students, to be administered by the health and physical education department.	79	27
The aim of the health service program should be primarily educational rather than merely clinical.	78	30.5
Every college should have an advisory committee on health.	78	30.5
Athletic injuries should be treated by the health service department, and charges for services not included in the student health service fee should be paid for by the athletic department.	77	32
At least 30 minutes per student should be given for each health examination.	76	34
Students should be urged to call the college health service before calling off-campus service.	76	34
The same director should have charge of the men's and women's health service programs.	76	34
Duties of the health staff members should include teaching of hygiene or health education as needed.	75	36
*Minor surgical treatment should be included as a part of the health service fee.	74	38.5
*The college health service staff should include a psychiatrist.	74	38.5
All nurses should be required to take prescribed courses in public health training before being placed in the department.	74	38.5
There should be a physician for every 800 students registered.	74	38.5
Health service fees should provide at least 75% of the cost of the health service department.	72	41
Student counselors should receive complete reports of the health examination of students assigned to them for guidance.	71	42.5
*The health service department should plan and carry on an organized research program.	71	42.5
A complete health record should be an integral part of the student's college transcript.	70	44
Wasserman tests should be required of all students at least once yearly.	68	45
Faculty members should have access to the services of the health service department upon payment of the health fee.	67	46
All students should have health examinations immediately prior to graduation.	65	47
A physician should be present at each football session.	62	48
The health service department should operate under the division of health and physical education.	60	49
It is the responsibility of the college to furnish medical service in correcting remediable health defects, if the student is not financially able to pay for the service.	53	50
Health examinations by family or outside physicians are satisfactory for health service purposes.	47	51
Health service staff members should be allowed to accept individual fees from students for services.	33	52

*Suggested as essential policies for a college health program.

**All policies having a percent of 75 or more are suggested as minimum essential policies for a student health service program.

for a health service program on the basis of practice in the better health service programs and because of the fact that they are advocated by the leading authorities in the field of health service and health education.

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Motor Learning of Feeble-Minded Girls

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(Submitted for publication May, 1948)

A STUDY of motor learning of feeble-minded girls has significance in relation to possible contributions to our knowledge of motor learning of those of normal intelligence in addition to any benefit which may result from increasing knowledge about our mentally deficient. We know that there are marked individual differences among both mentally normal and subnormal subjects in ability to learn gross bodily motor skills. Studies by Brace,[1, 2] McNeely,[3] Hander,[4] McCloy,[5] and others have shown that in a normal homogeneous population of school age children or adults the correlation between motor learning and intelligence is about zero. Likewise studies indicate that coefficients of correlation between intelligence and such traits as strength, athletic ability, motor ability, and other physical fitness and performance tests are approximately zero, i.e., indicating a relationship little better than that due to pure chance. The findings being reported here indicate that in the case of the feeble-minded girls used in this study intelligence has more relationship to ability to learn motor skills and especially to measures of other physical traits than is the case with girls of normal intelligence of the same age level.

The data in this study were obtained by testing 50 girls at the Austin State School in 1945. The testing procedure was planned and tried out by the writer but the tests were given by a graduate student, Miss Wanda Stasieluk, and a teacher at the State School. Chronological ages of the girls ranged from 13 years and 7 months to 18 years and 8 months and showed a mean age of 15.77 years and standard deviation of 1.22 years.

Intelligence quotients were obtained from the records of the State School and ranged from I. Q.'s of 23 to 82 with a mean of 52.98 and standard deviation of 12.29.

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1 D. K. Brace. *Measuring Motor Ability.* New York: A. S. Barnes and Company, 1927, p. 88.

2 D. K. Brace. "Studies in the Rate of Learning Gross Bodily Motor Skills," *Research Quarterly* 12: 2 (May, 1941).

3 Frances E. McNeely. A comparative study of motor ability and rate of learning swimming skills. Unpublished master of education thesis, University of Texas, 1939, p. 47.

4 Irma Hander. Study of some factors influencing the speed of learning motor skills. Unpublished master of education thesis, University of Texas, 1935, p. 64.

5 Charles H. McCloy. *Tests and Measurements in Health and Physical Education.* New York: F. S. Crofts & Co., 1939, p. 66.

The tests used to measure ability to learn motor skills involving gross bodily activity and other physical traits were as follows:

Tests of Motor Learning

1. Tennis ball bounce: The test consisted of bouncing a ball on a tennis racket while standing in a six-foot circle and was repeated for a total of 30 trials. The test was scored as the number of consecutive bounces made on each trial.

2. Softball throw at a target: The test required the subject to throw a softball from a distance of 30 feet at a target consisting of three concentric circles. Thirty trials of 3 throws each were given. Each throw was scored 3 points for hits in the center circle, 2 points for the second circle, and 1 point for hits in the outer circle.

3. Soccer kick at a target: The test consisted of kicking a stationary soccer ball at a target on the gymnasium wall. The target consisted of 3 rectangles drawn each with a long side parallel to and at the floor. The inner rectangle was 2 x 3 feet, the second rectangle, 3 x 5 feet, and the third rectangle, 4 x 7 feet. Thirty trials of 3 kicks each were given with scores of 3 points for the inner rectangle, and 2 and 1 points for the second and third rectangles respectively.

Two methods of scoring the total efforts on each learning test were used, namely, the gross total score on all 30 trials, and the percent of possible gain obtained by dividing the actual gain after the first 5 trials by the possible maximum gain after the first five trials.

The so-called learning tests are similar to tests used with junior and senior high school girls and were designed especially to measure ability to improve (learn) in sport-type skills over a given number of trials. The percent of possible gain method of scoring was devised in an attempt to score improvement so as to equalize the effect of differences in original ability.

4. Motor Ability Test: The Brace Motor Ability test was used, with separate scorings on balance items and on agility items.

5. Athletic Index: T-scale scores on a 50-yard dash, standing broad jump and basketball throw for distance were combined to form the athletic index.

6. Strength: Strength was measured by combining T-scores on sit-ups and modified pull-ups and push-ups.

7. Physical Fitness Index: The physical fitness performance level tests (with substitution of 50-yard dash for potato race) designed for high school girls were used and scores combined into a single score. The tests used were the 50-yard dash, standing broad

jump, basketball throw, push-ups, pull-ups, sit-ups, and 10-second squat thrust.

All tests were given in accordance with standardized instructions. Where test scores were combined to form the measures indicated, they were converted into T-scale scores and added. Coefficients of correlation reported were obtained by use of the product-

$$\text{moment formula } r\ 12 = \frac{\frac{\Sigma X_1 X_2 - M_1 M_2}{N}}{\sigma_1 \sigma_2}$$

using raw scores where possible and calculated by machine.*

FINDINGS

It is the purpose of this paper to report results found relating to the motor learning of the particular group of feeble-minded girls studied. The various test data will be used only in this connection. It was particularly desired to study the relationship between intelligence, in terms of intelligence quotients, and ability to learn gross bodily motor skills. However, the relationship between intelligence and standardized motor tests is of interest in interpreting findings relating to motor learning.

Reliability of the learning tests determined by the split-half method are as follows: tennis ball bounce, $r = .993$; softball throw at target, $r = .936$; and soccer kick, $r = .430$.

The relationships between intelligence quotients and motor learning tests are shown in Table II. It is seen that the correlations are all low with the exception of that between intelligence and the soccer-kick test. In this case the correlation of .515 is marked and is higher than would be expected in the case of the same-aged girls of normal intelligence. Evidently the amount of improvement made on the learning tests was not greatly influenced by degrees of intelligence, a condition found to hold true also in the case of subjects of normal intelligence.

TABLE I

CORRELATIONS BETWEEN INTELLIGENCE QUOTIENTS AND MOTOR LEARNING TESTS

Learning Tests Correlated with I.Q.	*r*	*P.E.*
Tennis ball bounce, total score	—.115	.094
Softball accuracy throw, total score	.152	.093
Soccer kick, total score	.515	.070
Gross total score on all three learning tests	.246	.089
Total percent of gain score on all three learning tests	.304	.086

* Most of the computations were made by a teaching fellow, Mr. Lynn McCraw.

The relationships between intelligence and tests of various physical abilities are shown in Table II. The results shown in this table indicate a fair degree of relationship between intelligence scores and scores on the various physical tests. This is an interesting finding in that it differs markedly from the results of similar testing on subjects of normal intelligence. The writer believes one possible explanation may be that girls with more intelligence have been able to participate more freely with normal girls in physical activities. It may also indicate that higher degrees of intelligence have helped the girls to learn the motor skills involved. In any case, however, the relationship between intelligence and performance of motor skills is too low to have predictive value.

TABLE II

CORRELATIONS BETWEEN INTELLIGENCE AND VARIOUS TESTS OF PHYSICAL ABILITIES

Tests Correlated with I.Q.	*r*	*P.E.*
1. Brace Motor Ability (1st trial only)	.315	.086
2. Brace Motor Ability (2nd trial only)	.499	.072
3. Brace Motor Ability (sum of two trials)	.497	.071
4. Balance Items of Brace Test	.549	.067
5. Agility Items of Brace Test	.387	.081
6. Standing Broad Jump	.390	.080
7. Basketball Throw for Distance	.342	.084
8. 50-yard Dash	.378	.082
9. Athletic Index (6 + 7 + 8)	.529	.068
10. Ten-Second Squat Thrust	.356	.084
11. Seven Physical Performance Tests (6 + 10 + 12)	.471	.074
12. Strength Index (Pull-ups + Push-ups + Sit-ups)	.406	.080
13. Total percent gain for 3 learning tests	.304	.086

A further examination of the relationship between intelligence and Brace Motor Ability test and Athletic Index through partial and multiple correlation indicates that the correlation between I. Q. and Brace Motor Ability test ($r = .315$) is greatly influenced by Athletic Index and becomes ($r = -.114$) when the effect of Athletic Index is partialed out. Correspondingly the correlation between I. Q. and Athletic Index ($r = .529$) remains about the same ($r = .460$) when the Brace test is held constant. In other words, it would appear that there is a considerable relationship between the intelligence of feeble-minded girls used in this study and their ability in the events comprising the Athletic Index, namely, 50-yard dash, standing broad jump, and basketball throw for distance. This relationship is very much less in the case of girls of the same age range having normal intelligence. For the feeble-minded girls studied there is a substantial relationship between I. Q. and the best combination of Motor Ability and Athletic Index as shown by the coefficient of multiple correlation of $R = .538$.

The partial and multiple coefficients relating to the above discussion are as follows:

1. I. Q. $r_{12} = .315$
2. Brace Motor Ability $r_{13} = .529$
3. Athletic Index $r_{23} = .724$

$r_{12.3} = -.114$
$r_{13.2} = .460$ $R_{1.23} = .538$
$r_{23.1} = .693$

Partial and multiple coefficients of correlation were obtained also between (1) I. Q., (2) balance items in the Brace test, and (3) total percent of gain on the three motor learning tests. As given in Table II there was, for some reason, a substantial correlation of .549 between I. Q. and the balance items of the Brace test. There was a high correlation ($r = .793$) between the balance items and the total percent of gain score on the three motor learning tests used.

The question arises as to the relationship between I. Q. and ability to improve on the learning tests as measured by the total percent of gain on the three learning tests. Using partial correlation technique it appears that the correlation between I. Q. and the Brace balance items ($r = .549$) remains about the same ($r = .532$) when the effect of the total percent of gain on the three learning tests is held constant. Likewise the substantial relationship of ($r = .793$) between the Brace balance items and total percent of gain on the learning tests drops only to ($r = .788$) when I. Q. is held constant. When the effect of the Brace balance items is held constant the correlation between I. Q. and total percent of gain on the learning tests drops from ($r = .304$ to $r = -.260$). This would indicate that, for the subjects of this study, the relationship between intelligence and ability to improve on the learning tests is about zero and is dependent on other factors such as motor ability.

The partial and multiple correlations relating to the above discussion are as follows:

1. I. Q.
2. Balance items in Brace test
3. Total percent gain on the three learning tests

$r_{12} = .549$; $r_{13} = .304$; $r_{23} = .793$
$r_{12.3} = .532$
$r_{13.2} = -.260$ $R_{1.23} = .581$
$r_{23.1} = .788$

The relationship between motor learning, as measured by total score on the three learning tests and the total percent of gain on the learning tests, and such standardized tests as those measuring motor ability, athletic ability, physical fitness performance, strength, balance, and agility are shown in Table III. The correlations reported are rather similar to those found in studies of girls of normal in-

telligence. An exception is the correlation between balance items and percent of gain on the learning tests. It is interesting to note that the correlation between total learning score (the sum of all scores on the learning tests) and Brace Motor Ability test increases when two trials are given. As indicated in Table II, intelligence may have operated to cause the increase.

TABLE III

CORRELATION BETWEEN MOTOR LEARNING SCORES AND CERTAIN STANDARDIZED PHYSICAL TESTS

Tests of Physical Abilities	*Correlation with Total Learning Score on 3 Learning Tests*	*Correlation with Total Percent of Gain on 3 Learning Tests*
Brace Motor Ability (1st trial)	.208 ± .091	.448 ± .076
Brace Motor Ability (2nd trial only)	.379 ± .082	
Brace Motor Ability (sum both trials)	.430 ± .077	
Balance items (Brace test)	.382 ± .081	.793 ± .037
Agility items (Brace test)	.590 ± .062	.602 ± .061
Athletic Index	.517 ± .070	.433 ± .077
Physical Fitness index (7 tests)	.308 ± .086	———
Strength (Push-ups, Pull-ups, Sit-ups)	.272 ± .088	———
Chronological age	.019 ± .095	

The two methods of scoring motor learning tests correlate .856; Athletic Index and physical fitness index correlate .906.

SUMMARY AND CONCLUSIONS

The purpose of this study has been to investigate the ability of feeble-minded girls to learn sport-type gross bodily motor skills, and to examine particularly the effect of intelligence on motor learning and performance of motor skills. Three "learning tests" and other standardized tests of motor ability, athletic ability, strength, and physical fitness performance were administered to 50 girls, ages 13 to 18, at the Austin State School (for feeble minded). The mean intelligence quotient of the girls was 52.98. The mean chronological age was 15.77 years.

The three motor learning tests involved 30 trials at bouncing a ball on a tennis racket, throwing a softball at a target, and kicking a soccer ball at a target. The learning tests were scored in two ways, namely, the gross total score, and the percent of possible gain following the first five trials.

The following conclusions, regarding the subjects tested, seem justified:

1. Intelligence, in terms of I. Q., of the feeble-minded girls studied, has slight relationship to ability to learn gross bodily motor skills of the sport type, and this relationship appears partly due to motor ability and general athletic ability and is so low as to have no predictive value.

2. In the case of the feeble-minded girls, I. Q. appears to have

more relationship to motor learning, motor ability, strength, and athletic ability than is the case with girls of the same age range but with normal intelligence.

3. There appears to be a rather close relationship ($r = .793$) between balance items of the Brace Motor Ability test, and total percent of gain on the three learning tests. This relationship seems to be independent of intelligence since it remains ($r = .788$) when intelligence is held constant.

4. There is a substantial relationship between I. Q. and the optimum combination of motor ability and athletic ability as shown by a multiple correlation of $R = .538$. This is undoubtedly higher than would be the case with girls of normal intelligence.

5. The relationship between I. Q. and Brace Motor Ability tests ($r = .315$) becomes ($r = -.114$) when the effect of Athletic Index is partialed out. Correspondingly, the correlation between I. Q. and Athletic Index ($r = .529$) remains about the same ($r = .460$) when the Brace Motor Ability test is held constant. This makes it appear that there is considerable relationship between the intelligence of feeble-minded girls used in this study and their ability in the events comprising the Athletic Index, namely, 50-yard dash, standing broad jump, and basketball throw for distance. This relationship is believed much closer than is the case with girls of the same age but with normal intelligence.

6. The correlation between I. Q. and balance items of the Brace test ($r = .549$) remains about the same ($r. = .532$) when the effect of the total percent of gain on the three learning tests is held constant. The relationship between I. Q. and balance items is probably much higher than would be expected in the case of girls with normal intelligence. The relationship between I. Q. and total percent of gain on the learning tests drops from ($r = .304$) to ($r = -.260$) when the effect of balance items is held constant. These findings apparently indicate that, for the subjects of this study, the real relationship between intelligence and ability to improve on the learning tests is very low when other factors such as motor ability are held constant.

7. One explanation of the findings may be that with individuals of very low intelligence slight differences in intelligence may have significant effect upon ability to learn and to perform gross bodily motor skills. It may be possible also that among youth of a very low level of intelligence the amount of intelligence has a significant bearing upon the amount of participation in physical activities that takes place during the important period of physical growth. It appeared to the writer, while working with the subjects being tested, that emotional reaction patterns, rather than lack of physical abilities, may have operated to produce poor performance scores.

Change In Certification Requirements of Physical Education Teachers in 13 States Since 1942

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(Submitted for publication May, 1948)

PURPOSE AND PROCEDURE

A STUDY by Morehouse and Schaaf[1] in 1942 showed a lack of agreement existing among the state laws as to certification of physical education teachers. Furthermore, at that time, a number of states were contemplating changes in their requirements. The desirability of uniform standards among states has been expressed by state directors and also by teacher-training faculty members of colleges and universities who must plan their curricula to meet state requirements in order to place their students in the schools of their own or nearby states. A survey of the present certification requirements has been conducted to study the nature of the changes in requirements which have been made.

METHOD AND RESULTS

Replies to requests for present certification requirements in physical education were received from all 48 states and were edited somewhat for uniformity. The edited form was returned to the states for approval and corrections were made as indicated. The 1942 and 1947 requirements were matched. Thirty-five states had not made any changes during that period.

The statements of the thirteen states which had physical education certification requirements altered are presented in Table I. It will be noted that these changes vary from an entirely new statement to changes of only minor items in the 1942 statement.

The changes in certification requirements in physical education have been summarized in Table II. An inspection of this table reveals that there are a greater number of states which have added units than those which have reduced requirements. The extremes in revision

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1 L. E. Morehouse and O. Schaaf, "Prerequisites for Teacher Certification in Physical Education in the United States," *Research Quarterly*, 13:3 (October, 1942).

represented are New Hampshire and Nevada. New Hampshire established a physical education requirement of twenty-four units, and Nevada excised its 18-unit requirement and now lists no units in their requirement. The greatest alteration was made by Utah which now lists forty physical education units, whereas, only five units were listed in 1942. Louisiana and South Carolina are now specifying course requirements rather than listing total units as before. No states have discontinued the practice of specifying courses and course-unit requirements.

The trend toward the addition of statements of courses and units in the state requirements has indicated the desirability of reviewing the requirements in order to see which courses are affected.

A summary of course changes is as follows:

COURSES ADDED

Indiana.—Orientation and Administration, Tests and Measurements in Health and Physical Education, Highly Organized Sports, Recreational Sports, Rhythmic Activities for Men, Activities for Elementary Grades.

Kansas.—Teaching Methods.

New York.—Camping.

COURSES DROPPED

New York.—Community Recreation, Hygiene.

INCREASED UNITS

New York.—Physical Inspection, First Aid and Safety, Administration, Organization and Supervision.

DECREASED UNITS

New York.—Physical Education for Atypical Children, Tests and Measurements.

Indiana added six new courses in their certification requirement without eliminating any. New York dropped some courses by name from their list of required courses but these courses could possibly be included in elective fields. New York also increased the unit requirements in three courses and reduced the unit requirements in two courses without changing the total requirement.

Louisiana and South Carolina did not specify courses in 1942 but do so now. The courses specified by these states are summarized as follows:

Louisiana and South Carolina.—Principles, Organization, Administration, Health Education.

Louisiana.—Basic Sciences, Anatomy and Physiology.

South Carolina.—History, Philosophy, First Aid and Safety, Personal and Community Health, Materials and Applied Techniques.

It is noted that the new requirements are not exactly like that of any other state. The opportunity for progress toward uniformity in these instances was neglected.

SUMMARY

The state certification requirement for physical education teachers of the thirteen states which have made changes since 1942 has been reviewed. A summary of the review is as follows:

1. Louisiana and South Carolina now specify course requirements. No state which heretofore has specified courses required for certification has discontinued this practice.

2. Seven states have increased physical education unit requirements for certification. Three states have reduced the unit requirements. Nevada has eliminated all unit requirements in physical education and now requires only a high school certificate to teach any subject.

3. All states which listed semester-unit requirements along with course listings continue to do so. Two states, Louisiana and South Carolina, which now specify course requirements also specify unit requirements for each individual course.

4. No two states yet have the same requirements.

TABLE I

THIRTEEN STATES WHICH HAVE CHANGED THEIR CERTIFICATION REQUIREMENTS FOR PHYSICAL EDUCATION TEACHERS SINCE 1942

IDAHO

1942: Sixty-four semester hours, of which 15 semester hours are in education and 25 semester hours in physical education.

1947: A bachelor's degree with a major or a minor in physical education.

INDIANA

1942: Graduate with a baccalaureate degree with 15 semester hours in education. Also 24 semester hours of physical education which shall include: gymnastic exercises, 3 semester hours; theory and practice of play, 3 semester hours; coaching of athletics, 5 semester hours (women may substitute to the extent of rhythm courses); general physiology, anatomy, health education, 5 semester hours; physical examinations and individual gymnastics, 3 semester hours. Electives not coaching of athletics. They may be chosen from organization and administration of physical diagnosis, or first aid.

1947: Graduate with a baccalaureate degree with 15 semester hours in education. Also 22 semester hours of physical education which shall include: orientation and organization, 4 semester hours; tests and measurements in health and physical education, 3 semester hours; technique for (a) sports, highly organized, 3-4 semester hours; (b) sports, recreational, 3-4 semester hours; (c) gymnastics (tumbling, apparatus tactics, calisthenics, body mechanics, and individual athletic events), 3 semester hours; (d) rhythmic activ-

ities (folk, clog, social, modern, tap), 3-2 semester hours; (e) activities for elementary grades, 3-2 semester hours.

Kansas

1942: An applicant who will teach in a school where credit in physical education is required for graduation must have graduated from a four-year college. He must have had 15 semester hours in physical education, 10 hours of which must be in the fields of health, physiology, first aid, or school hygiene, and 18 semester hours in education.

1947: An applicant who will teach in a school where credit in physical education is required for graduation must have been graduated from a four-year college. He must have had fifteen semester hours in the field of health, physiology, first aid or hygiene, and 10 semester hours in the field of physical education, including teaching methods and physical education.

Louisiana

1942: A four-year degree with 4½ college session hours or 9 semester hours in physical education. He is authorized as a part-time special teacher if he has a major of 20 college session hours or 40 semester hours. (A definitely established evaluation of the distribution of these hours is done by the director of certification with the cooperation of the state supervisor of health, physical and safety education.)

1947: A four-year degree, and for certification as a fully qualified teacher of health and physical education or coach, the requirement of 41 semester hours is distributed as follows: (1) principles, organization and administration, 5 semester hours; (2) basic science, 3 semester hours; (3) health education, 6 semester hours; (4) professional techniques, 18 semester hours; (5) anatomy and physiology, 6 semester hours; (6) electives in physical education, 3 semester hours. (A definitely established evaluation of the distribution of these hours is done by the director of certification with the cooperation of the state supervisor of health, physical and safety education.)

Nevada

1942: Bachelor of arts or bachelor of science degree which includes 18 semester hours of training in the field of professional education, including 4 semester hours of practice teaching. The majority of the hours in educational subjects must be in the secondary field.

1947: Any teacher who holds a Nevada high school certificate is permitted to teach any subject in the high school curriculum, including physical education.

New Hampshire

1942: Graduate of a standard post-secondary institution designed to train teachers of physical education and complete 12 semester hours of work in education.

1947: Graduate of a standard post-secondary institution designed to train teachers of physical education and complete 12 semester hours of work in education, plus 24 semester hours in the field of physical education.

New Mexico

1942: A college degree with appropriate majors and minors with a minimum of 10 semester hours in physical education.

1947: A college degree with appropriate majors and minors with a minimum of 10 semester hours in physical education, and in addition, 3 semester hours in the specific subject taught.

New York

1942: Approved four-year curriculum leading to the baccalaureate degree including 18 semester hours in professional education courses and 36 semester hours of physical education.

The special courses required are (time given in semester hours): *Prerequisites:* general anatomy, 2; general physiology, 4; biology, 6; hygiene, 2; elective science, 4. *Fields:* Applied anatomy, 2-4; physical inspection, first aid, and safety education, 2-4; physical education for atypical children, 3-4; physical education tests and measurements, 3-4; community recreation, 2-4; administration, organization, and supervision of physical education and hygiene, 4-6.

Physical education skills and applied technics, 14-16: (1) group games of low organization, men, 2 and women, 2; (2) dual and single games, men, 3 and women, 3; (3) group games of high organization, men, 3 and women, 2; (4) rhythms and dances, men, 2 and women, 4; (5) aquatics, men, 1 and women, 1; (6) gymnastics and stunts, men, 3 and women, 2.

1947: Approved four-year curriculum leading to the baccalaureate degree, including 18 semester hours in professional education courses and 36 semester hours of physical education.

Special courses required are (time given in semester hours): *Prerequisites:* 18 semester hours in science, including one course in each of the following fields: anatomy, physiology, biology, and bacteriology. *Fields:* Applied anatomy, 2-4; physiology of exercise, 2-4; physical inspection, 2-4; first aid and safety, 2-3; physical education tests and measurements, 2-4; administration, organization, and supervision (physical education, recreation, and camping), 6-8.

Physical education skills and applied technics, 14-16: (1) group games of low organization, men, 2 and women, 2; (2) dual and single games, men, 3 and women, 3; (3) group games of high organization, men, 3 and women, 2; (4) rhythms and dances, men, 2 and women, 4; (5) aquatics, men, 1 and women, 1; (6) gymnastics and stunts, men, 3 and women, 2.

Oregon

1942: Baccalaureate degree with 37 quarter hours of professional education and 12 quarter hours each of physical education and health education.

1947: Graduation from a standard college, university, or teacher's college, the completion in a standard college, university, or teacher's college of five-year secondary teacher-training course or its equivalent of at least 45 quarter hours beyond the requirements for the baccalaureate degree which must include 40 quarter hours of Oregon history and Oregon school law and system of education.

In addition to meeting these requirements, the applicant must submit official evidence of the completion of 24 semester or 36 quarter hours in physical education, or a major in that field.

South Carolina

1942: Major in physical education.

1947: Major in physical education, including history, principles, philosophy, organization, and administration, 4-6; health education (first aid and safety, including personal and community health), 3-4; materials and applied techniques, 14-17. Also basic sciences such as physiology and anatomy, 4-6; Chemistry and/or physics, 6-8.

Tennessee

1942: Graduation from a four-year college or university. Course must have included 27 quarter hours in education and at least 18 quarter hours in physical education.

1947: Graduation from a four-year college or university. Course must have included 27 quarter hours in education and at least 20 quarter hours in physical education.

Utah

1942: A college course of four years which includes 30 quarter hours in health, safety, and physical education, together with a teaching major of at least 30 hours and a teaching minor of 18 hours. It is not required that the major or minor be in physical education, but it is strongly recommended.

1947: Four-year college course which includes a composite major of 60 quarter hours in physical education and subjects allied to physical education; or in lieu of a composite major, a major of 30 quarter hours in physical education and a minor of 18 quarter hours in academic subjects.

Wisconsin

1942: Graduation from a four-year course which includes 18 semester hours of education and a major of 30 semester hours in physical education.

1947: Graduation from an accredited four-year college or university course with a minor of at least 20 semester hours in physical education.

TABLE II

Summary of Changes in State Requirements for Certification of Teachers of Physical Education

Change in Requirements	*States*	*1942*	*1947*
Add physical education units	Kansas	5	10
	Louisiana	40	41
	New Hampshire	0	24
	New Mexico	10	13
	Oregon	18	24
	Tennessee	12	13
	Utah	5	40
Reduce physical education units	Indiana	24	22
	Nevada	18	0
	Wisconsin	30	20
Degree instead of total semester units	Idaho		
Teaching certificate instead of degree	Nevada		
Specify courses instead of total units	Louisiana		
	South Carolina		
Shifted courses and unit requirements but held unit total constant	New York		
From 4- to 5-year program	Oregon		

Swimming Achievement Scale Scores for College Men

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(Submitted for publication June, 1948)

SWIMMING achievement scores for college men have been used for the past six years in the aquatic program at the University of California. Similar scale scores have been worked out for boys and girls at the high school level (1). Tests have a definite place in a physical education program only when the results are beneficial to the student.

Institutions with large enrollments are confronted continually with the problem of classifying their pupils into homogeneous groups. Each semester much valuable time is lost when the instructor attempts to appraise the ability of a student without the use of an objective test. Self-evaluation by the student is not a reliable measure of ability as many pupils have no idea what their capabilities are. If students can be grouped according to skill, teaching efficiency is greatly enhanced. The teacher becomes cognizant at the outset of pupil difficulties, weaknesses, and gaps in learning for the particular skill in question. By separating the unskilled individual from the more advanced, the slow learner is prevented from becoming frustrated and discouraged and likewise the skilled individual is prevented from losing interest. Segregation keeps the enthusiasm and interest in learning for all levels at a higher pitch than would otherwise be possible if the classes were heterogeneous. It is mandatory in any classification scheme for the instructor to set up graded programs for ability levels and within each group to gear the instruction to the learning rates of the individual performers.

Another problem confronting the instructor of aquatic sports at the college level is that of giving a final grade. Objective tests, showing the degree of individual advancement of facility from the start to the conclusion, can be of material aid to the teacher in assigning a mark, rather than subjectively evaluating the performance by guess. Where there are tests, how much more satisfactory it is for both teacher and student when some objective yardstick is available. Achievement scales are not to be construed as being the only measure of importance because of their objectivity. If the

whole pupil is to be educated, the teacher must subjectively evaluate the non-measurable factors such as attitude, understandings, and personality development until the day that such tests are scientifically developed.

Performance tests serve as an incentive and motivate the learner to practice skills in good form. The better the form the more satisfaction and enjoyment comes from the activity.

If the rating of ability in different events is transposed into scale-score units with a range from 0 to 100 and the mean at 50 points, the student can readily comprehend this estimate of his ability, since it is similar to that used for other subjects. Scale-scores of this nature were successfully used during the last war and since have been revised with a number of tests added to meet postwar aquatic objectives(2).

TESTS

Results given in Table I were gathered by testing over 4,000 college men at the University of California during the past six years.

The following tests* were given in a pool twenty-five yards long:

1. Time in tenths of seconds required for an underwater swim of 20 and 25 yards.

2. Number of yards covered during endurance swim of 15 minutes.

3. Time in tenths of seconds to sprint 25 yards using the crawl, the breast and back-crawl strokes.

4. Time in tenths of seconds to swim 50 yards using the crawl, the breast, and the back-crawl strokes.

5. The number of strokes used in swimming 50 yards with the elementary back, side, and breast strokes.

All the scores were placed in a frequency distribution and computations were then made of the means and standard deviations. For each test, the mean was set at a scale-score of 50. A scale-score of 100 represents a performance of five standard deviations above the mean, whereas a score of 0 represents a scale-score of five standard deviations below the mean. To derive the step increment, the sigma for each test was multiplied by five and then divided by 50. By using standard scores in this manner, all events are comparable. This permits both the teacher and the pupil to compare the student's ability or score performance in one test with that of another swimming event.

The reliability of this procedure was determined by retesting a group of 200 boys on two separate occasions without any intervening instruction. Product moment r is as follows: 25-yard under-

* A description of these tests will be found at end of article.

TABLE I

SWIMMING ACHIEVEMENT TEST SCALES FOR COLLEGE MEN USING 25-YARD POOL

	Underwater Swim (Seconds)		*15-Min. Endurance Swim*	*25-Yard Sprint Swim* (Seconds)			*50-Yard Sprint Swim* (Seconds)			*50-Yard Glide and Relaxation* (No. of Strokes Used)			
Pts.	*20 Yds.*	*25 Yds.*	*Yds.*	*Crawl*	*Breast*	*Back*	*Crawl*	*Breast*	*Back*	*Elem. Back*	*Side*	*Breast*	*Pts.*
100	11.0	15.1	1025	11.5	15.0	15.0	25.0	33	30	9	9	9	100
99	11.1	15.3	.....	.....	15.1	.....	.....	...	...	...	...	...	99
98	11.2	15.4	.....	11.6	15.2	15.2	25.3	...	...	...	...	...	98
97	11.3	15.6	1000	.....	15.4	.....	25.6	34	...	10	10	...	97
96	11.4	15.7	.....	11.7	15.5	15.4	25.9	...	31	...	...	10	96
95	11.6	15.8	.....	.....	15.6	15.6	26.2	35	...	...	...	...	95
94	11.7	16.0	.....	11.8	15.7	.....	26.5	...	...	11	11	...	94
93	11.8	16.1	975	11.9	15.8	15.8	26.8	...	32	...	...	11	93
92	11.9	16.2	.....	.....	16.0	16.0	27.1	36	...	...	...	...	92
91	12.0	16.4	.....	12.0	16.1	.....	.....	...	...	12	12	...	91
90	12.1	16.5	950	12.1	16.2	16.2	27.4	...	33	...	...	...	90
89	12.2	16.8	.....	.....	16.3	16.4	.....	37	...	...	...	12	89
88	12.4	16.9	.....	12.2	16.4	.....	27.7	...	...	13	13	...	88
87	12.6	17.0	.....	12.3	16.5	16.8	28.0	38	34	...	...	...	87
86	12.7	17.2	925	12.4	16.7	17.0	28.3	...	...	...	...	...	86
85	12.8	17.3	.....	.....	16.8	.....	28.6	...	...	14	14	13	85
84	12.9	17.5	.....	12.5	16.9	17.2	28.9	39	35	...	...	...	84
83	13.0	17.6	900	.....	17.0	17.4	29.2	...	...	...	...	...	83
82	13.1	17.7	.....	12.6	17.1	.....	29.5	...	...	15	15	14	82

TABLE I (Continued)

81	13.3	17.9	.....	12.7	17.2	17.6	29.8	40	36	...	...	....	81
80	13.4	18.0	875	12.8	17.4	17.8	.....	...	...	16	16	...	80
79	13.5	18.2	.....	.....	17.5	.....	30.1	41	...	...	...	15	79
78	13.6	18.4	.....	12.9	17.6	18.0	30.4	...	37	...	...	...	78
77	13.7	18.5	.....	.....	17.7	18.2	30.7	...	...	17	17	...	77
76	13.8	18.7	850	13.0	17.8	.....	31.0	42	...	...	...	16	76
75	13.9	18.8	.....	13.1	18.0	18.4	31.3	...	38	...	...	...	75
74	14.1	19.0	.....	13.2	18.1	18.6	31.6	...	...	18	18	...	74
73	14.2	19.1	825	.....	18.2	.....	31.9	43	...	...	...	17	73
72	14.3	19.3	.....	13.3	18.3	18.8	32.2	...	39	...	...	...	72
71	14.4	19.4	.....	.....	18.4	19.0	32.5	44	...	19	19	...	71
70	14.5	19.5	800	13.4	18.5	.....	.....	...	...	...	...	...	70
69	14.6	19.7	.....	13.5	18.7	19.2	32.8	45	40	...	...	18	69
68	14.7	19.8	.....	.....	18.8	19.4	33.0	...	...	20	20	...	68
67	14.9	20.0	775	13.6	18.9	19.6	33.3	...	41	...	...	...	67
66	15.0	20.2	.....	13.7	19.0	19.8	33.6	46	...	21	21	19	66
65	15.1	20.3	.....	.....	19.1	20.0	33.9	...	...	...	...	...	65
64	15.2	20.5	.....	13.8	19.2	.....	34.2	...	42	22	22	...	64
63	15.3	20.6	750	.....	19.4	20.2	34.5	47	...	...	...	20	63
62	15.4	20.7	.....	.....	19.5	20.4	34.8	...	...	...	...	...	62
61	15.6	20.8	.....	13.9	19.6	.....	35.1	...	43	23	23	...	61
60	15.7	20.9	725	14.0	19.7	20.6	.....	48	...	...	...	...	60
59	15.8	21.0	.....	.....	19.8	20.8	35.4	...	...	...	...	21	59
58	15.9	21.1	.....	14.1	20.0	.....	35.7	...	44	24	24	...	58
57	16.0	21.2	700	.....	20.1	21.0	35.9	49	...	...	...	...	57
56	16.1	21.3	.....	14.2	20.2	21.2	36.2	...	45	...	...	22	56
55	16.2	21.4	.....	.....	20.3	.....	36.5	...	...	25	25	...	55
54	16.3	21.5	.....	14.3	20.4	21.4	36.8	50	...	...	...	...	54
53	16.4	21.6	675	14.4	20.5	21.6	37.1	...	46	...	...	23	53
52	16.5	21.7	.....	14.5	20.7	.....	37.4	51	...	26	26	...	52
51	16.6	21.8	.....	.....	20.8	21.8	37.7	....	....	....	....	....	51

TABLE I (Continued)

	Underwater Swim (Seconds)		*15-Min. Endurance Swim*	*25-Yard Sprint Swim* (Seconds)			*50-Yard Sprint Swim* (Seconds)			*50-Yard Glide and Relaxation* (No. of Strokes Used)			
Pts.	*20 Yds.*	*25 Yds.*	*Yds.*	*Crawl*	*Breast*	*Back*	*Crawl*	*Breast*	*Back*	*Elem. Back*	*Side*	*Breast*	*Pts.*
50	16.7	21.9	650	14.6	21.0	22.0	38.0	52	47	27	27	24	50
49	16.9	22.1	.....	.....	21.1	.....	38.3	....	....	....	....	....	49
48	17.0	22.3	.....	14.7	21.2	22.2	38.6	....	....	....	....	25	48
47	17.1	22.4	.....	14.8	21.4	.....	38.9	53	48	28	28	....	47
46	17.2	22.6	625	.....	21.5	22.4	39.2	....	....	....	....	....	46
45	17.4	22.7	.....	14.9	21.6	22.6	39.5	54	....	....	....	26	45
44	17.6	22.8	.....	15.0	21.7	.....	39.8	....	49	29	29	....	44
43	17.7	23.0	.....	.....	21.8	22.8	.....	....	....	....	....	....	43
42	17.8	23.2	600	15.1	22.0	23.0	40.1	55	....	....	....	27	42
41	17.9	23.3	.....	.....	22.1	.....	40.4	....	50	30	30	....	41
40	18.0	23.5	.....	15.2	22.2	23.2	40.7	....	....	....	....	....	40
39	18.1	23.6	575	15.3	22.4	23.4	41.0	56	51	....	....	28	39
38	18.3	23.7	.....	15.4	22.5	.....	41.3	....	....	31	31	....	38
37	18.4	23.9	.....	.....	22.6	23.8	41.6	....	....	....	....	29	37
36	18.5	24.0	.....	15.5	22.7	24.0	41.9	57	52	32	32	....	36
35	18.6	24.2	550	.....	22.9	.....	42.2	....	....	....	....	....	35
34	18.7	24.4	.....	15.6	23.0	24.2	42.5	....	....	....	....	30	34
33	18.9	24.6	.....	15.7	23.1	24.4	.....	58	53	33	33	....	33
32	19.0	24.7	525	15.8	23.2	.....	42.8	....	....	....	....	....	32
31	19.1	24.9	.....	.....	23.4	24.6	43.0	....	....	....	....	31	31

TABLE I (Continued)

30	19.2	25.0	.....	15.9	24.6	24.8	43.3	59	54	34	34	....	30
29	19.4	25.1	.....	.....	24.7	.....	43.6	....	....	....	....	....	29
28	19.6	25.2	500	16.0	24.8	25.0	43.9	60	55	....	....	32	28
27	19.7	25.4	.....	16.1	25.0	25.2	44.2	....	....	35	35	....	27
26	19.8	25.5	.....	16.2	25.1	.....	44.5	61	....	....	....	....	26
25	20.0	25.8	475	.....	25.2	25.4	44.8	....	56	....	....	33	25
24	20.1	25.9	.....	16.3	25.4	25.6	45.1	....	....	36	36	....	24
23	20.3	26.0	.....	16.4	25.6	.....	.....	62	....	....	....	34	23
22	20.4	26.2	.....	.....	25.7	25.8	45.4	....	57	37	37	....	22
21	20.5	26.3	450	16.5	25.9	26.0	45.7	63	....	....	....	....	21
20	20.6	26.5	.....	16.6	26.0	.....	45.9	....	58	....	....	35	20
19	20.7	26.6	.....	16.7	26.1	26.2	46.2	....	....	38	38	....	19
18	20.9	26.7	425	.....	26.2	26.4	46.5	64	....	....	....	....	18
17	21.0	26.9	.....	16.8	26.4	26.6	46.8	....	59	....	....	36	17
16	21.1	27.0	.....	.....	26.6	26.8	47.1	....	....	39	39	....	16
15	21.3	27.2	.....	16.9	26.7	27.0	47.4	65	60	....	....	....	15
14	21.4	27.4	400	17.0	26.8	.....	47.7	....	....	....	....	37	14
13	21.6	27.5	.....	17.1	27.0	27.2	48.0	....	....	40	40	....	13
12	21.7	27.6	.....	.....	27.2	27.4	.....	66	61	....	....	....	12
11	21.8	27.8	.....	17.2	27.3	.....	48.3	....	....	....	....	38	11
10	22.0	28.0	375	.....	27.4	27.6	48.6	....	....	41	41	....	10
9	22.1	28.1	.....	17.3	27.5	27.8	48.9	67	62	....	....	....	9
8	22.3	28.3	.....	17.4	27.7	.....	49.2	....	....	42	42	39	8
7	22.4	28.4	.....	17.5	27.9	28.0	49.5	68	....	....	....	....	7
6	22.6	28.6	.....	.....	28.0	28.2	49.9	....	63	....	....	....	6
5	22.8	28.7	350	17.6	28.1	.....	50.2	69	....	43	43	40	5
4	23.0	28.9	.....	.....	28.3	28.4	50.5	....	....	....	....	....	4
3	23.1	29.1	.....	17.7	28.4	28.6	50.8	....	64	....	....	....	3
2	23.3	29.3	.....	17.8	28.6	28.8	———	70	....	44	44	41	2
1	23.4	29.4	.....	17.9	28.8	29.0	51.1	....	....	....	....	....	1
0	23.6	29.6	325	18.0	29.0	29.2	51.4	71	65	45	45	42	0

water swim, .94 ∓ .03; 15 minute swim, .89 ∓ .02; 50-yard sprint swim for crawl, .90 ∓ .02, breast, .89 ∓ .01, back, .91 ∓ .03; 50-yard glide and relaxation for the elementary back, .95 ∓ .03, side stroke, .91 ∓ .01, and breast stroke, .92 ∓ .02.

Correlations between achievements in individual events and total score were set up by summating the scores made in the above tests. This total was then taken as the criterion for all-round college swimming ability in men.

The individual events were found to correlate with the criterion (total score) as follows: 25-yard underwater swim, $r = .88 \mp .03$; 15-minute endurance swim, $r = .72 \mp .02$; 50-yard sprint swim for the crawl, $r = .67 \mp .01$, breast, $r = .54 \mp .03$, and back crawl stroke, $r = .57 \mp .04$; 50-yard glide and relaxation ability for the elementary back stroke, $r = .90 \mp .02$, side stroke, $r = .93 \mp .01$, and breast stroke, $r = .75 \mp .03$. Since the inter-correlations of the 25- and 50-yard crawl, breast, and back strokes all fell within an r of .90 or above, it is apparent that the instructor should select either the 25-yard or the 50-yard distance, but not both, for the test.

In order to determine probable relationships between the student's gliding or resting ability and the number of strokes required for a 50-yard swim, correlations were worked out for the elementary back, side, and breast strokes. Three judges stood on opposite sides of the pool and noted how long in seconds each swimmer held his glide.** If a swimmer could hold the glide four counts (seconds), he was given a score of four, for example. Counts were made for three complete strokes, the average being used as the final score.

This score was then correlated with the total number of strokes necessary for the 50-yard swim. Pearson product moment r for the elementary back stroke was .90 ∓ .08, the side stroke, .86 ∓ .02, and the breast stroke, .91 ∓ .03. Three experts in swimming also graded the students' form on the basis of 10 as perfect. The sum of these scores given by the judges was then correlated with the total number of strokes employed for the 50-yard swim. For the elementary back stroke, r was .92 ∓ .01, for the side stroke, .99 ∓ .007, and the breast stroke, .93 ∓ .03.

If tests are to be used for classification of students and time is an important factor, a short battery may be selected. At the University of California, where large numbers of students must be classified quickly, it has been found that a combination of the 25-yard or 50-yard crawl plus the three gliding strokes (elementary back, side, and breast) proves highly satisfactory for purposes of segregation. This short battery test can be completed during the first period with a group of 80 or 100 boys without being hurried. It correlates with the criterion (total scores) .87 ∓ .02.

** Each judge practiced counting seconds with a stop watch prior to the test.

Administration of College Swimming Tests

20- and 25-Yard Underwater Swim

Use a regulation start and swim the entire distance underwater. The finish must be made underwater. Any style of swimming may be used.

Scoring: Record time in tenths of seconds. No score given if any part of the body comes to the surface.

15-Minute Endurance Swim

Use a regulation start and allow any style turn. Continue swimming until whistle blows. Each swimmer counts his own lengths.

Scoring: Convert lengths into yards. If a swimmer is over one-half a length at the finish, score as a full length, if under half a length, disregard extra distance. No score is given for swimming less than 15 minutes.

25- and 50-Yard Sprint Swims for the Crawl, Breast, and Back Strokes

Select either the 25- or 50-yard distance. Use a regulation start.

Scoring: Record time in tenths of seconds. No score given for those failing to complete entire distance.

50-Yard Glide Relaxation Ability for the Elementary Back, Side and Breast Strokes

Elementary Back Stroke: Start in the water. Push-off with arms at side of body and legs together. Use a frog kick. Arms may be raised above the shoulders on the recovery. No arm or leg action allowed on the push-offs.

Scoring: Record number of push-offs plus number of strokes as total strokes.

Side Stroke: Start in water using regulation push-off for start and for turn. Push-off into gliding position with lower arm extended over the head and upper arm along side of the hip. No arm or leg action allowed on push-offs. Only one leg action allowed per arm action while stroking. Use single underarm or underwater side stroke and not the overarm side stroke.

Scoring: Record number of push-offs plus strokes used as total strokes.

Breast Stroke: Start in water using regulation above-water push-off for start and for turn. Push-off into a gliding position with arms extended over head and legs together. No arm pull or leg kick allowed on push-offs. Use regulation breast stroke. No butterfly or dolphin stroke allowed. Only one arm and leg action allowed per stroke.

Scoring: Count push-offs plus number of strokes as total strokes.

REFERENCES

1. Hewitt, Jack E. Achievement scale scores for high school swimming. In press.

2. Hewitt, Jack E. Achievement scale scores for wartime swimming. *Research Quarterly*. 14:4 (December 1943), pp. 391-396.

A Note on Scaling Some Measures Of Circulation and Respiration

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TEST construction for the measurement of the functions of circulation and respiration has been concerned chiefly, since its inception about 1900, with the selection of a *least number* of variables descriptive of these functions. The earlier tests were constructed empirically both in the selection and in the combination of variables as well as scaling procedures. More recently, with the introduction of correlational methods into the study of physiology, variables have been selected on the basis of the size of the correlation coefficient with a selected criterion. Further statistical methods have been applied in combining and weighting test items. In all instances, procedures have not been established for the scientific scaling according to an accepted physiologic criterion, nor according to approved statistical procedures. The purpose of this analysis, therefore, is to advance a procedure for scaling which adapts the system to the conventional physiologic interpretation. The variables selected in the study have resulted from a factor analysis of a larger number.

STATEMENT OF PROBLEM

It is the purpose of this analysis to prepare statistical scales for certain selected circulatory-respiratory items which have resulted from a factor analysis study. Certain assumptions, which have not been tested, are inherent in the process of scaling. The six-sigma statistical range has been applied with divisions into five categories of 1.2 sigma each. The qualitative descriptions have then been made according to conventional physiology. For example, it is assumed that the excellent category (Table II) should contain 1.2 sigmas whether scaling started at the mean of the distribution or at +3 sigma or —3 sigma. It will be noted, therefore, that the excellent category for systolic pressure contains 44.9 percent (Table II) while the excellent category for pulse rate contains 3.8 percent. The only logic which can be advanced for this decision is the acceptance of the biological normal curve; that is, there are more people having systolic pressures of 124 (mean) with 1.2 sigma range than people having

pulse rates of 52 with the same range. It seemed more desirable to hold the statistical unit constant and allow the percentage to vary with each item which is the complete acceptance of the normal curve and the sigma unit as its description. If for some reason this logic is not supported by experimental evidence, the value of the scale is not lost as the standard scores may be used without qualitative description. The limits of the five qualitative categories can then be disregarded. Of course, the problem of whether or not the scaled scores stand the experimental test also is to be determined. It is acknowledged, therefore, that experimental work is needed to either accept or reject these hypotheses.

PROCEDURE

Experimental.—This study utilizes the results of a factor analysis study by the writer for the purpose of selecting the variables which represent the primary components of the factors isolated in the research.[1] It is recognized that a complete array of tests did not comprise this experiment; therefore, the resulting factors are limited, of course, to the nineteen items used. Ten test batteries were also included, but they did not constitute a basis for identification because of their complexities.

The data for the preparation of the scales were those collected at Springfield College, from Carlisle (Penn.) soldiers,* and Pensacola fliers.* The data available for each item with the means and standard deviations (basic statistics for the construction of the scale) are found in Table II. These data represent a highly conditioned group of young men (Pensacola data), an average conditioned group (Springfield data), and a poorly conditioned group (Carlisle data). The results on the McCurdy-Larson Test confirm this selection (Table I). The age range for all three groups is 18 to 24.

TABLE I

PHYSIOLOGIC CHARACTERISTICS OF SELECTED GROUPS
(McCurdy-Larson Test)

Population	*Mean*	*Standard Deviation*
Pensacola Fliers	221.85	88.49
Springfield	162.30	86.70
Carlisle	110.28	78.76

Statistical.—The scale for each item consists of 100 points distributed over a six-sigma range. Three scaling patterns are used: first, the distribution of scores from low (100 points) to high (0 points) values (pulse rate); second, the distribution of scores

[1] Leonard A. Larson. "A Factor Analysis of Some Cardovascular-Respiratory Variables and Tests," *Research Quarterly*, 18:2 (May, 1947), pp. 109-122.

* Data collected by the late Dr. J. H McCurdy.

from high (100 points) to low (0 points) values (vital capacity); and, third, the distribution of scores from the mean (100 points) to high (0 points) and low (0 points) values (systolic pressure). It is also necessary to determine the nature of the progression of scores, that is, whether it should follow a linear or a non-linear sequence. Because of the lack of experimental evidence, it was assumed that the linear pattern would probably more nearly approximate the various degrees and adjustments in function. The increments for each score between 0 to 100 were therefore calculated by dividing six times sigma by 100 (Tables II and III). The mean or plus or minus three sigma served as starting points for scaling procedures. For example, when scaling pulse rate, the value at +3 sigma (52) was arbitrarily assigned a value at 100 , the mean (72) 50, and the value at —3 sigma (106) 0. The systolic pressure and other items scaled starting at the mean were arbitrarily assigned a value of 100 (124) and the values at +3 sigma (160) and —3 sigma (90) 0.

The five qualitative ratings (Tables II and III: Excellent, Very Good, Good, Poor, and Very Poor) contain 1.2 sigma units each. The statistical method followed two plans. First, when either a high (vital capacity) or low (pulse rate) represented desirable function, the mean served as a starting point by computing a value at .6 sigma above and .6 sigma below as the "Good" classification. The remaining four categories were computed at 1.2 sigma units consecutively above and below the .6 sigma point. Second, when the mean score (systolic) represents desirable function, the excellent category was determined at a value also .6 units above and below the mean. However, the remaining classifications were computed .6 sigma units consecutively above and below this point. The very good category, for example, contained scores falling between plus and minus .6 sigma and plus and minus 1.2 sigma.

LIMITATIONS

Some limitations of the devised scale have already been presented. In addition, the study contains all the limitations reported in the factor analysis study by the writer. Other limitations are as follows:

1. Whether or not the selected items represent all factors does not invalidate this study, however, as it is delimited to the variables selected, and the study is concerned chiefly with scaling of the selected items.

2. In the process of scaling, plus and minus deviations of the same magnitude are considered equal. Whether such an assumption will be supported with experimental evidence remains to be demonstrated.

3. The scale also is more heavily weighted with well conditioned individuals (naval fliers and Springfield College).

TABLE II

TABLE II

STATISTICAL BASIS FOR CARDIOVASCULAR-RESPIRATORY SCALE*
(AS PRESENTED IN TABLE III)

Selected Variable	*Descriptive Analysis of Data (Springfield, Carlisle, Pensacola)*				*Percentage of Subjects in each of five categories*					*Arbitrary Scaling References*		
	M	*σ*	*N*	*Range*	*Excellent*	*Very good*	*Good*	*Poor*	*Very poor*	*100*	*50*	*0*
Horizontal Pulse Rate	72.12	10.80	772	52 to 106	3.8**	22.2	44.7	27.6	1.7	$+3\sigma$	Mean	-3σ
Difference: Std.-Hor. Pulse Rates	15.40	6.74	139	32 to 0	5.8	15.3	55.5	18.4	5.0	$+2.5\sigma$	Mean	-3σ
Difference: PR 2′ after Ex. Std. Nor. PR	—0.66	10.36	1262	—32 to 32	50.9	28.3	13.7	4.7	2.4	Mean		$+3\sigma$ -3σ
Horizontal Systolic Pressure	123.70	11.88	634	160 to 90	44.9**	33.6	13.8	5.0	2.3	Mean		$+3\sigma$ -3σ
Difference: Std.-Hor. Systolic Pressure	—7.14	7.03	139	—36 to 12	2.2	25.3	45.3	24.2	2.9	$+3\sigma$	Mean	-3σ
Horizontal Diastolic Pressure	71.44	9.58	635	100 to 42	44.4	32.5	15.7	5.7	1.7	Mean		$+3\sigma$ -3σ
Standing Diastolic Pressure	84.84	10.45	1255	116 to 53	49.5	30.5	12.6	4.7	2.8	Mean		$+3\sigma$ -3σ
Difference: Std.-Hor. Diastolic Pressure	10.65	8.12	139	—16 to +36	42.5	24.9	15.9	4.1	2.5	Mean		$+3\sigma$ -3σ
Horizontal Pulse Pressure	54.29	12.98	508	90 to 15	43.7	35.4	13.8	5.1	2.1	Mean		$+3\sigma$ -3σ
Difference: Std.-Hor. Pulse Pressure	—18.25	9.16	139	—48 to 0	3.7	25.3	42.5	24.4	4.2	$+2\sigma$	Mean	-3σ
Breath Holding 20″ after Exercise	28.52	10.98	1261	4 to 72	5.7	14.2	52.4	27.1	0.5	$+3\sigma$	Mean	-2.5σ
Vital Capacity, 63-65 in.	4421	775	53	3000 to 6800	3.6	18.2	52.8	25.2	0.2	$+3\sigma$	Mean	-2σ
Vital Capacity, 66-68 in.	4783	732	245	2800 to 6600	4.9	22.6	44.1	24.8	3.7	$+3\sigma$	Mean	-2.5σ
Vital Capacity, 69-71 in.	5379	738	339	3400 to 7400	5.8	20.7	45.0	25.3	3.1	$+3\sigma$	Mean	-3σ
Vital Capacity, 72-74 in.	5862	764	173	3800 to 7600	3.1	28.2	38.2	26.9	3.7	$+3\sigma$	Mean	-3σ
McCurdy-Larson Test	171.18	97.76	1229	—200 to 480	4.2	21.7	46.3	24.7	3.1	$+3\sigma$	Mean	-3σ

* The use of the mean and standard deviation as a system of scaling assumes normality of distribution. The graphic inspectional method of testing for normality was applied (normal curve superimposed on a frequency polygon for each distribution.) The distributions of the selected variables did not deviate sufficiently from the line of normal curve to warrant a more accurate test of normality as a basis for final judgment of normality for each item.

** See explanation on first page of article.

4. The problem of validity is not a concern of this study. The scale is prepared to be used in a scaled manner in research or for individual or group description.

5. The scale, because of the numbers used, is considered highly stable for the selected population. Individuals using the scale, however, must be concerned with the reliablity of their score.

APPLICATION OF SCALE

The scale has two applications, namely, research and individual or group description. In the former, it is in many instances preferred that scaled items be used in a statistical analysis rather than unscaled measures. Systolic pressure, for example, correlated in raw units will not permit a physiological interpretation in a manner similar to systolic pressure when correlated with scaled units. In the latter, the scale can be used to evaluate physiological status insofar as the physiological scope permits. The items can be used singly or in any combination desired. For example, an individual with a horizontal pulse rate of 55 and a breath-holding-after-exercise score of 60, would have an average index score of $\frac{93 + 97}{2} = 95$. This is classified as excellent.

CONCLUSIONS

1. Certain physiological variables, which have resulted from a factor analysis study, have been selected for scaling purposes. The working hypotheses underlying the scoring procedures seem reasonable, both statistically and physiologically, but will need further study before they can be fully established.

2. Combinations of variables may be used for research and descriptive purposes. These are devised on the assumption that scaled scores are in many instances more valuable in research and individual or group description than unscaled scores, particularly when variables differ in their interpretation.

TABLE III

A CARDIOVASCULAR-RESPIRATORY RATING SCALE*, **

CARDIOVASCULAR-RESPIRATORY STANDARDS	HORIZONTAL PULSE RATE		DIFFERENCE: STD. - HOR. PULSE RATES		DIFFERENCE: PULSE RATE 2 MINUTES AFTER EXERCISE - STD. HOR. PULSE RATE				HORIZONTAL SYSTOLIC PRESSURE				DIFFERENCE: STD. - HOR. SYSTOLIC PRESSURES		HORIZONTAL DIASTOLIC PRESSURE				STANDING DIASTOLIC PRESSURE				DIFFERENCE: STD. - HOR. DIASTOLIC PRESSURES				HORIZONTAL PULSE PRESSURE				DIFFERENCE: STD. - HOR. PULSE PRESSURES	
					ABOVE MEAN		BELOW MEAN		ABOVE MEAN		BELOW MEAN				ABOVE MEAN		BELOW MEAN		ABOVE MEAN		BELOW MEAN		ABOVE MEAN		BELOW MEAN		ABOVE MEAN		BELOW MEAN		
	HOR. P.R.	SCORE	DIFF. P.R.	SCORE	DIFF. P.R.	SCORE	DIFF. P.R.	SCORE	HOR. S.P.	SCORE	HOR. S.P.	SCORE	DIFF. S.P.	SCORE	HOR. D.P.	SCORE	HOR. D.P.	SCORE	STD. D.P.	SCORE	STD. D.P.	SCORE	DIFF. D.P.	SCORE	DIFF. D.P.	SCORE	HOR. P.P.	SCORE	HOR. P.P.	SCORE	DIFF. P.P.	SCORE
EXCELLENT	52	100	0	100	0	100	0	100	124	100	124	100	14	100	72	100	72	100	85	100	85	100	11	100	11	100	54	100	54	100	0	100
													13	98													55	99	53	98		
			1	98	1	96	-1	96	125	97	123	98	12	95	73	99	71	99	86	98	84	99	12	92	10	97	56	98	58	95	-1	97
	53	98			2	94	-2	94	126	94	122	96	11	93					87	95	83	96					57	95	51	93		
			2	94			-3	91	127	91	121	95	10	90	74	98	70	98					13	87	9	94					-2	96
					3	91	-4	88	128	88	120	90	9	88			69	95	88	91	82	94					58	91	50	90		
	54	95	3	92	4	88	-5	85	129	86	119	87	8	85	75	95	68	91	89	88	81	93	14	82	8	91	59	88	49	88	-5	91
					5	85	-6	82	130	83	118	84	7	83	76	91	67	88	90	84	80	91	15	78	7	88	60	84	48	85	-4	88
	55	93	4	88	6	82	-7	80	131	80	117	81	6	80	77	88	66	84	91	81	79	88	16	73	6	82	62	77	47	83	-5	93
	56	90	5	84	7	80	-8	76	132	77	116	78	5	78	73	84	65	81	92	77	78	84	17	69	5	78	63	74	46	80	-6	82
	57	87											4	76													64	70	45	78	-7	79
	58	85	6	82	8	76	-9	73	133	75	115	75			79	81	64	77	95	74	77	82			4	73						
	59	83									114	72	3	74													65	67	44	75	-8	76
			7	78	9	73	-10	70	134	72			2	72	80	77	63	74	96	70	76	77	18	64								
	60	80									113	69															66	65	43	73	-9	73
VERY GOOD	61	78	8	74									1	70							75	74			3	69						
	62	75			10	70	-11	67	135	69	112	66			81	74	62	70	93	67							67	60	42	70	-10	70
	63	73	9	71									0	68							74	70	19	60								
									136	66	111	65													2	64	68	56	43	65	-11	67
	64	70	10	68	11	67	-12	64					-1	66							73	66										
	65	68							137	64	110	60			82	70	61	67	96	63							69	53	40	65	-12	64
	66	65	11	64	12	64	-13	61	138	61	109	57	-2	64																		
													-3	62	83	67	60	63	97	60	72	63	20	55	1	60	70	49	39	63	-13	61
	67	63	12	61	13	61	-14	58	139	58	108	54	-4	60	84	63	59	60	98	56	71	59	21	50	0	55	73	46	38	60	-14	58
	68	60																													-15	55
	69	58	13	57	14	58	-15	55	140	55	107	51	-5	58	85	60	58	56	99	53	70	56					72	42	37	58	-16	58
	70	55	14	54									-6	54									22	46	-1	50					-17	53
	71	53							141	53	106	48							100	49							73	39	36	55		
	72	50	15	50	15	55	-16	52					-7	50	86	56	57	53			69	53									-18	50
	73	49							142	50	105	45							101	46			23	41	-2	46	74	35	35	53	-19	49
GOOD	74	48	16	48									-8	49													75	32	34	50	-20	47
	75	47			16	52	-17	49	143	47	104	42			87	53	56	49			68	49									-21	46
	76	45	17	45									-9	48					102	42			24	37	-3	42	76	28	33	46	-22	44
	77	44	18	42	17	49	-18	46	144	44	103	39	-10	45	88	49	55	46			67	45									-23	43
	78	42																	103	39							77	25	32	45	-24	43
	79	41	19	39	18	46	-19	43	145	42	102	36	-11	43	89	46	54	42	104	35	66	42	25	33	-4	37	78	21	31	43	-25	41
	80	39	20	36	19	43	-20	40	146	39	101	33	-12	40	90	42	53	39	105	32	65	39	26	28	-5	33	79	20	30	40	-25	40
	81	38	21	33																									29	38	-26	38
					20	40	-21	37	147	36	100	30	-13	38			52	35									80	18				
	82	36	22	30									-14	35	91	39			106	28	64	35	27	24	-6	28			28	35	-27	37
	83	35																									81	16			-28	35
			23	27	21	37	-22	34	148	33	99	27	-15	33			51	32	107	29	63	32							27	33	-29	34
	84	33																													-30	32
POOR	85	32	24	24			-23	31	149	31	98	24	-16	30	92	33							28	19	-7	24	82	14	26	30	-31	31
					22	34											50	28	108	21	62	28										
	86	30	25	21			-24	28	150	28	97	21	-17	28													83	12	25	28	-32	29
	87	29	26	18	23	31							-18	25	95	32	49	25	109	18	61	25	29	15	-8	19					-33	28
	88	27	27	15			-25	25	151	25	96	18	-19	23													84	10	24	25	-34	26
	89	26	28	12	24	28	-26	22	152	22	95	15	-20	20	94	38	48	21	110	14	60	21	30	10	-9	15	85	9	23	23	-35	25
	90	24	29	9	25	25	-27	19	153	20	94	12	-21	18	95	25	47	18	111	13	59	18	31	8	-10	10	86	8	22	20	-36	23
	91	23																													-37	22
	92	21			26	22	-28	16	154	17	93	9	-22	15	96	21	46	14	112	12	58	14							21	18	-38	20
	93	20											-23	13									32	6	-11	7	87	6	20	15	-39	19
	94	18			27	19			155	14											57	11										
	95	17	30	6			-29	13					-24	10	97	18	45	11	113	9									19	13	-40	17
	96	15			28	16			156	11	92	6									56	7	33	4	-12	4	88	4			-41	16
VERY POOR	97	14											-25	8															18	10	-42	14
	98	12			29	13	-30	10	157	9					98	14	44	7	114	6											-43	9
	99	11																			55	5										
	100	9	31	3	30	10							-26	5									34	2	-13	2	89	2	17	8	-44	6
	101	8							158	6	91	3			99	7	43	4	115	3	54	2										
	102	6					-31	5					-27	3															16	5	-45	3
	103	5			31	5			159	3																						
	104	3											-28	0	100	0	42	0	116	0	53	0	35	0	-14	0	90	0	15	0	-46	0
	105	2																														
	106	0	32	0	32	0	-32	0	160	0	90	0																				

*Each variable is independently scaled. This permits the use of single variables or combination of any desired number. Standard scores can be score. Circle score when making record, e.g., horizontal pulse rate, 58, circle 85 as score.

**Administered in the McCurdy-Larson test.

II

ORT RATING SCALE*, **

	DIFFERENCE: STD. - HOR. DIASTOLIC PRESSURES				HORIZONTAL PULSE PRESSURES				DIFFERENCE: STD. - HOR. PULSE PRESSURES		BREATH HOLDING 20 SECONDS AFTER EXERCISE		VITAL CAPACITY CORRECTED FOR HEIGHT								McCURDY-LARSON ORGANIC EFFICIENCY TEST	
	ABOVE MEAN		BELOW MEAN		ABOVE MEAN		BELOW MEAN						63 - 65 INCHES		66 - 68 INCHES		69 - 71 INCHES		72 - 74 INCHES			
	DIFF. D.P.	SCORE	DIFF. D.P.	SCORE	HOR. P.P.	SCORE	HOR. P.P.	SCORE	DIFF. P.P.	SCORE	B.H.	SCORE	V.C.	SCORE	V.C.	SCORE	V.C.	SCORE	V.C.	SCORE	O.E.T.	SCORE
	11	100	11	100	54	100	54	100	0	100	62	100	6400	100	6500	100	7400	100	7600	100	470	100
											61	99	6350	99			7350	99	7750	99	460	96
	12	93	10	97	55	99	53	98			60	97	6300	98	6450	99	7300	98	7700	98	450	95
					56	98			-1	97	59	96	6250	97	6400	98	7250	97	7650	97	440	93
	13	87	9	94			52	95			58	94	6200	95			7200	97	7600	95	430	92
					57	95			-2	96	57	93	6150	94	6350	97	7150	94	7550	94	420	90
	14	82	8	91	58	92	51	93			56	92	6100	93			7100	93	7500	93	410	89
											54	88	6050	92	6300	95	7050	92	7450	92	400	87
					59	88	50	90	-3	91	53	87	6000	90			7000	90	7400	90	390	86
	15	78	7	88			49	88			52	85	5950	89	6250	94	6950	89	7350	89	380	84
					60	84			-4	88	51	84	5900	87			6900	88	7300	88	370	83
							48	85			50	82	5850	86	6200	92	6850	87	7250	87	360	82
					61	82					49	81					6800	85	7200	85	350	81
	16	73	6	82	62	77	47	83	-5	85	48	79	5800	85	6150	91	6750	84			347	80
	17	69	5	78	63	74	46	80	-6	82	47	78	5750	84	6100	88	6700	83	7150	84	346	79
											46	76	5700	83	6050	86	6650	82	7100	83	345	78
					64	70	45	78	-7	79			5650	82	6000	85	6600	80	7050	82		
			4	73							45	75	5600	80	5950	83	6550	79	7000	80	340	77
					65	67	44	75	-8	76			5550	79	5900	82	6500	78	6950	79	330	76
	18	64									44	73	5500	77	5850	80	6450	77	6900	78		
											43	72	5450	76	5750	79	6400	75	6850	77	320	75
			3	69	66	63	43	73	-9	73	42	70	5350	75	5700	77	6350	73	6800	75	310	74
											41	69	5300	74	5650	76	6250	72	6750	74	300	72
					67	60	42	70	-10	70			5250	73	5600	74	6200	70	6700	73	290	70
	19	60									40	67	5200	72	5550	73	6150	69	6650	72	280	68
											39	66	5150	71	5500	72	6100	68	6600	70		
			2	64	68	56	41	68	-11	67			5100	70	5450	70	6050	67	6550	69	270	67
											38	64	5050	69	5400	68	6000	65	6500	68	260	65
					69	53	40	65	-12	64			5000	67								
											37	63	4950	64	5350	67	5950	64	6450	67	250	64
											36	61	4900	63	5300	65	5900	63	6400	65		
	20	55	1	60	70	49	39	63	-13	61	35	60	4850	62	5250	64	5850	61	6350	64	240	62
													4800	60	5200	62	5800	60	6300	63	230	61
	21	50	0	55	72	46	38	60	-14	58	34	58	4750	59	5150	61	5750	59	6250	62	229	59
									-15	55	33	57	4700	58	5100	59	5700	58	6200	60	215	58
					72	42	37	58					4650	57	5050	58	5650	57	6150	59		
									-16	52	32	55	4600	55	5000	56	5600	55	6100	58	200	56
	22	46	-1	50							31	54	4550	54	4950	55	5550	54	6050	57	190	55
					73	39	36	55	-17	51												
											30	52	4500	53	4900	53	5500	53	5950	54	180	53
					74	35	35	53	-18	50	29	51	4450	52	4850	52	5450	52	5900	53	170	50
	23	41	-2	46					-19	49	28	50	4400	50	4800	50	5400	50	5850	52		
					75	32	34	50					4350	48	4750	49	5350	49	5800	50	160	47
									-20	47	27	48	4300	46	4700	47	5300	48	5750	49	150	46
	24	37	-3	42	76	28	33	48	-21	46	26	46	4250	44	4650	46	5250	47	5700	47	140	44
											25	44	4200	42	4600	44	5200	45	5650	46		
									-22	44	24	42	4150	40	4550	43	5150	44	5600	45	130	43
					77	25	32	46			23	40	4100	38	4500	41	5100	42	5550	44	120	41
									-23	48	22	38	4050	36	4450	40	5050	41	5500	42	115	40
	25	33	-4	37	78	21	31	43	-24	41			4000	34	4400	38	5000		5450	40	113	39
	26	28	-5	33	79	20	30	40	-25	40	21	36	3950	32	4350	37	4950		5400	39	112	38
															4300	35	4900			37		
					80	18	29	38	-26	38	20	34			4250	34	4850	37		36	100	37
									-27	37	19	32	3900	30	4200	32	4800	35	5200	35	90	36
	27	24	-6	28			28	35	-28	35	18	30	3850	28	4150	31	4750	34	5150	34	80	35
					81	16									4100	29	4700	32	5100	32	70	34
							27	33	-29	34	17	28	3800	26	4050	28	4650	31	5050	31		
															4000	26	4600	30	5000	30	60	32
	28	19	-7	24	82	14			-30	32	16	26			3950	25	4550	29	4950	29	50	31
							26	30					3750	24	3900	25	4500	28	4900	27		
									-31	31	15	24			3850	22	4450	27	4850	26	40	29
					83	12									3800	20	4400	25	4800	25		
							25	28	-32	29	14	22	3700	22	3750	19	4300	22	4750	24	30	28
	29	15	-8	19											3700	17	4250	21	4700	22		
															3650	16	4200	20			20	26
					84	10			-33	28	13	20							4650	21		
							24	25					3650	20	3600	14	4150	19			10	25
									-34	26	12	18			3550	13	4100	18	4600	20	0	23
	30	10	-9	15	85	9	23	23	-35	25	11	16	3600	18	3500	11	4050	17	4550	19		
															3450	10	4000	15	4500	17	-5	22
	31	8	-10	10	86	8	22	20	-36	23	10	14	3550	16	3400	8	3950	14	4450	16	-6	21
									-37	22	9	12	3500	14					4400	15	-20	20
							21	18							3350	7	3900	12				
	32	6	-11	7	87	6			-38	20	8	10	3450	11			3850	11	4350	14	-30	18
							20	15	-39	19			3400	8	3300	5	3800	10	4300	12	-40	16
											7	8	3350	7			3750	9	4250	11		
							19	13	-40	17									4200	10	-50	14
	33	4	-12	4	88	4			-41	16	6	6	3300	6	3250	4	3700	8	4150	9	-60	12
							18	10					3250	5			3650	7	4100	7	-70	10
									-42	14	5	5	3200	4	3200	3	3600	5	4050	6	-80	8
							17	8	-43	9	4	4	3150	3			3550	4	4000	5	-90	6
	34	2	-13	2	89	2			-44	6			3100	2	3150	2	3500	2	3950	4	-100	4
							16	5			3	2							3900	2		
									-45	3			3050	1			3450	1	3850	1	-110	2
	35	0	-14	0	90	0	15	0	-46	0	2	0	3000	0	3100	0	3400	0	3800	0	-122	0

ny desired number. Standard scores can be summed and averaged as an index
re.

The Measurement of the Strength of Muscle Relative to the Cross Section

By Carrie Belle Morris

University of Alabama

University, Alabama

(Submitted for publication, June, 1948)

INTRODUCTION

THE purpose of this study was to measure the strength of muscles per square centimeter of cross section. The muscles used were the flexors and the extensors of the forearms and of the lower legs of twenty-four subjects. With two exceptions the subjects, twelve men and twelve women, were students at the State University of Iowa.

Review of related studies.—Two studies, both by German scientists, were made to measure the absolute strength of a muscle relative to its cross section. The first study reported by Fick (5) gave an estimated amount of force per square centimeter of six to ten kilograms. Recklinghausen (2) in his research on amputees estimated the strength to be 3.6 kilograms per square centimeter. The difference in the results of these studies has caused much controversy, and it was hoped that the present study would give evidence to strengthen either Fick's or Recklinghausen's findings, or to give new results.

Also related to this problem is the apparent difference in strength of men and women of the same age, height, and weight. In an unpublished study made by Wendler* the total strength of men was found to be 40 percent greater than that of women. Baldwin (1) found boys superior to girls at every age (seven through seventeen years) in the strength of the right arm, the left arm, and upper back. Brady (3) found from adding the strength of legs, back, and right and left grips of boys and girls that girls have 82 percent of the strength of boys. In Brady's study, body weight was held constant, and the age range was eleven through fourteen years.

* A. J. Wendler, personal communication.

Physiological and mechanical principles.—It has been found that strength is relative to the physiological cross section of a muscle, a section which includes nearly all the fibers. An anatomical cross section is the same as the physiological cross section only in a muscle in which the fibers run parallel with one another and in line with the tendon (e.g., the biceps brachialis). In a muscle such as the rectus femoris in which the fibers are oblique to the long axis, the physiological cross section may be at an oblique angle to the anatomical cross section (7).

The absolute power of a muscle has been defined by Steindler as being equal to "maximum display of contractile power" (10). This maximum contraction occurs when the muscle is not allowed to shorten but resists an immovable force.

Since muscles are instruments of force for moving the bony levers of the body, the leverage or mechanical advantage of the muscle cannot be overlooked. Other things being equal, the muscle with its attachment farther from the fulcrum moves the lever arm over a smaller arc but with greater force than a muscle moving a lever with a smaller radius (10). This proportional muscular efficiency can be obtained by dividing the length of the force arm by that of the resistance arm.

PROCEDURE

Data.—The following anthropometric measurements were taken on each subject:

1. Right upper-arm girth at the largest part, depth, width, and four fat measurements (dorsal, ventral, medial, lateral) at this level.
2. Elbow-styloid length.
3. Right thigh girth at a level one-half the distance between the top of the greater trochanter and the bottom of the lateral condyle of the femur; depth, width, and four fat measurements at this level.
4. Tibiale-sphyrion length.

Method of computation.—From the collected data an arm circumference corrected for fat was calculated, and the depth and width corrections were computed, from which the area of the cross section was figured. Similar computations were made from the leg measurements of each subject. Arm measurements for one subject are recorded in Table I.

TABLE I

RAW DATA WITH COMPUTED CROSS SECTION AND MUSCLE AREAS FOR ONE SUBJECT'S ARM MEASUREMENTS

Arm Measurements	*Raw Measurements*	*Measurements Corrected for Fat*
Circumference	30.5 cm	27.5 mm
Depth	10.6 cm	9.75 cm
Width	8.5 cm	7.7 cm
Fat—front	11 mm	
back	18 mm	
outside	22 mm	
inside	11 mm	
Elbow-styloid	30.3 cm	
Strength—flexors	84 K	
extensors	50 K	
Force arm—biceps	3.9 cm (from x-ray)	
brachialis	3.9 cm	
triceps	1.8 cm	
brachioradialis	6.9 cm	
Area	55.12 cm (from formula)	
Areas of Arm Muscles (method described in text)		
Biceps	10.66 cm	
Brachialis	11.48 cm	
Triceps	23.35 cm	
Brachioradialis	4.88 cm	

$$\frac{\text{Arm area}}{\text{Muscle proportion}} = \text{Muscle area}$$

$$\frac{55.12}{.1934} = 10.66 \text{ cm (biceps)}$$

From the external measurements corrections for fat for the subject whose data appear in this study were made in the following way:

Arm circumference = 30.5 cm.

The four quantity fat measurements were averaged. From this 6 mm. was subtracted because the scale on the calipers used started at 6.

11 mm.
18 mm.
22 mm.
11 mm.

4/ 62 mm. = 15.5 mm.
— 6

9.5 mm. ÷ 10 = .95 cm. x π = 2.996 or 3.0 cm. fat

30.5 cm.
— 3.0

27.5 cm. corrected circumference

Arm depth = 10.6

To correct for fat, the front and back fat measurements were averaged (14.5 — 6 = 8.5 mm. ÷ 10 = .85 cm.) This quantity was subtracted from 10.6, and the remainder was 9.75. The .85 cm. correction was divided by 2 to remove one thickness of the double thickness of fat measured by the calipers, and it was then multiplied by 2 for fat front and back The same method was used in correcting measurements of width.

Similar corrections were made for the measurements taken from the leg. The areas of the cross sections were computed according to the following formula:

Area = Width x Depth — {.6036 [2 (W x D) — Circumference]}.[2] This formula was developed by Clark (4) for measuring the area of a section of the chest from three measurements, width, depth, and circumference. It was learned that the formula has been verified for use in measuring the thigh, calf, upper arm, and forearm.*

After computing the areas in the cross sections of the arm and leg, it was necessary to find the approximate area of each muscle used in the strength test. This was done by obtaining the average proportions of each muscle from two sets of cross section drawings (6, 9). The areas of these muscle drawings were measured by means of a disc planimeter. A correction for two pennate muscles was added to the proportions. To the rectus femoris 50 percent was added, and to the vastus intermedius 25 percent was added allowing for the pennate arrangement of fibers in the cross section. These percentage increments were estimates based on an examination of the muscles of a cadaver. Table II gives the proportions of area used for each muscle. The largest area of the muscle was used in figuring the proportions, even though the largest area for all muscles was not at the same level.

For each subject an x-ray (10 in. x 12 in.) of the knee and elbow joints was taken, with each joint at a 90-degree angle. From these x-rays estimates of muscle attachments on the bones were made in order to get the leverage of the pertinent muscles.

Muscle attachments were located in the following way. On the elbow x-ray a metal pointer was placed against the tendon of the biceps. Thus there was obtained a line parallel to the humerus and directed to the point of insertion on the radius. The middle of the joint became the fulcrum. The distance between the two points became the force arm for both the biceps and the brachialis. The insertions of these two muscles are relatively equidistant from the fulcrum. For the triceps the length of the force arm was the distance between the fulcrum and the olecranon process. The resistance arm for the flexors and extensors was the elbow-stylion length minus

* C. H. McCloy, personal communication.

the distance between the olecranon process and the fulcrum on the x-ray. The leverage became the force arm divided by the resistance arm. The leverage for the brachioradialis was calculated in a different way because the line of pull was at an angle with, rather than parallel to, the bone. A line extended from the pointer to the humerus with the same angle as the observed tendon gave the point of origin from which the force arm was measured. The length of the force arm divided by that of the resistance arm gave the tangent of the angle of pull, which was converted to the sine. This obtained proportion represents the mechanical efficiency of the brachioradialis.

TABLE II

PROPORTIONAL SIZES OF MUSCLES RELATIVE TO CROSS SECTION AREAS

Arm Muscles	*Proportions*
Flexors:	
Biceps brachii	.1934
Brachialis	.2083
Brachioradialis	.0885
Extensors:	
Triceps brachii	.4271
Leg Muscles	
Flexors:	
Biceps femoris	.1036
Semimembranosus	.0685
Semitendinosus	.0504
Gracilis	.0360
Extensors:	
Rectus femoris (50 percent added area is included)	.1277
Vasti	.4066
Vastus intermedius (25 percent added area is included)	
Vastus medialis	
Vastus lateralis	

To compute the leg leverages, points were marked on the x-ray relative to the insertions of the muscles. For example, the force arm for the biceps is the distance of a line dropped from the middle of the joint (fulcrum) to a point level with the proximal end of the fibula; for the semimembranosus, a point level with the posterior part of the medial condyle of the tibia is taken; for the semitendinosus and the gracilis the point is level to the union between the shaft and head of the tibia.

The drawings of sample x-rays in Figure 1 illustrate the method that was used in approximating the leverage. In order to get a rough check on these computations of the leverages, muscle attachments were measured in illustrations from anatomy books and the leverages computed. The similarity of findings led to the assumption that the leverages were reasonably accurate.

In addition to the body measurements, four pertinent muscle

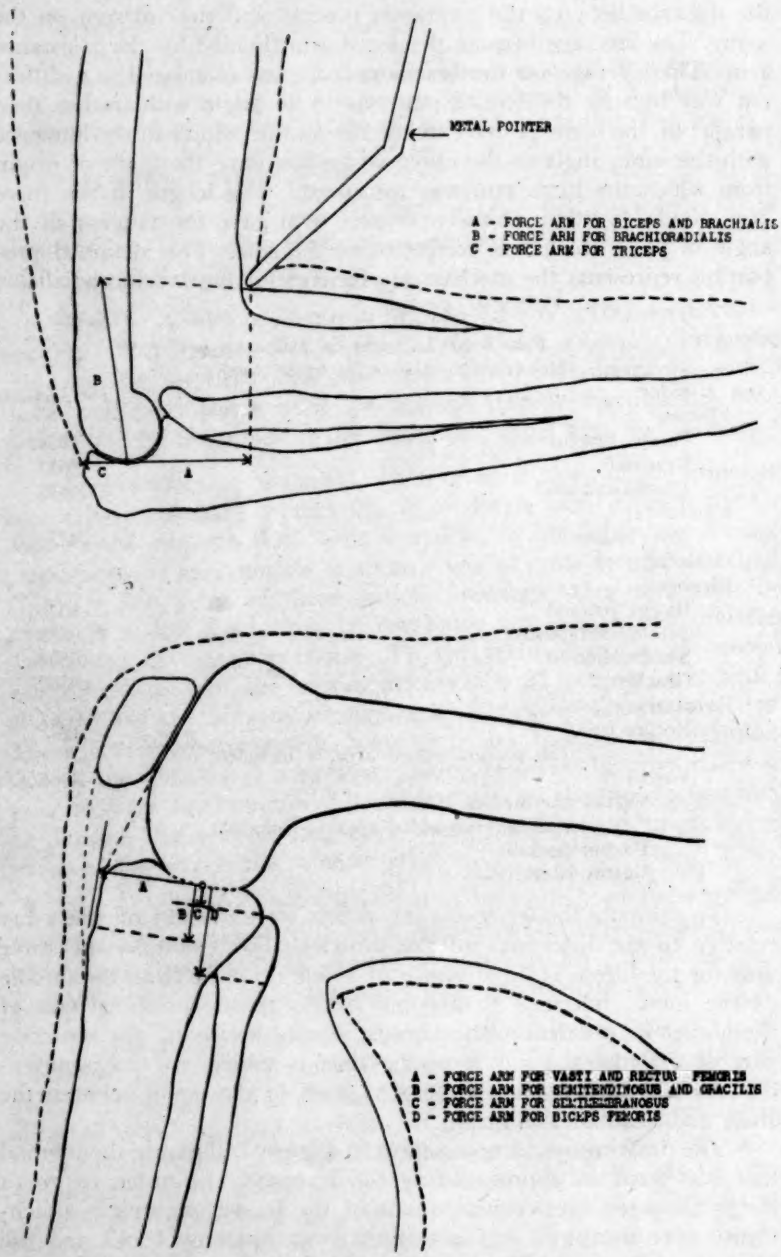
METAL POINTER
A - FORCE ARM FOR BICEPS AND BRACHIALIS
B - FORCE ARM FOR BRACHIORADIALIS
C - FORCE ARM FOR TRICEPS
A
B
C
A
A - FORCE ARM FOR VASTI AND RECTUS FEMORIS
B - FORCE ARM FOR SEMITENDINOSUS AND GRACILIS
C - FORCE ARM FOR SEMIMEMBRANOSUS
D - FORCE ARM FOR BICEPS FEMORIS

Fig. 1. Tracings of Sample Elbow and Knee X-Rays Used in Computing Leverages.

groups in each subject were tested for strength. The method of testing was that of Martin's break test (8). The hand dynamometer with a push-pull attachment was used. This test of strength was selected because it was a passive type (resisting an immovable force). Bethe (2) found that a passive test gives an average of about 46 percent more strength than the active strength test. The right forearm flexors and extensors were tested from a right-angle position of the elbow, with a strap from the wrist to the push-pull attachment of the dynamometer. For the leg flexors and extensors the subject assumed a prone position, with the right knee bent to a right angle and with the strap placed around the ankle. The measurements referred to earlier and the strength tests were administered on three different days for each subject. The average measurement and the best strength test for each muscle group were used in the calculations.

From the x-rays the leverage of each muscle was calculated and combined with the muscle cross-section areas and strength to obtain the force produced per square centimeter. Computations for the arm muscles of the subject whose data are recorded in Table I are given below. A similar method was used in computing the strength of the leg muscles.

Arm flexors

Resistance arm	28.5 cm	$\frac{3.9}{28.5} = .14$
Force arm, biceps, and brachialis	3.9 cm	
Leverage, biceps, and brachialis	.14	
Force arm, brachioradialis	6.9 cm	
Leverage, brachioradialis	.23	

$\frac{6.9}{28.5} = .24$ tan; .23 = sine and leverage

Strength 84 lbs.

	area	*leverage* % ÷ 100	*strength*
Biceps and brachialis	22.14 x .14 = 3.04	÷ 4.18 = .73	x 84 =
Brachioradialis	4.88 x .23 = 1.14	÷ 4.18 = .27	x 84 =

4.18

	leverage	lbs.	kilograms
Biceps, brachialis	61.03 ÷ .14 =	445.45 =	202.48 ÷ 22.14 =
Brachioradialis	22.97 ÷ .23 =	98.18 =	44.63 ÷ 4.88 =

Biceps, brachialis	9.15 K/cm.^{2}	= 9.15 K/cm.^{2}
Brachioradialis	9.14 K/cm.^{2}	

Arm extensors

Resistance arm	28.5 cm	
Triceps force arm	1.8 cm	$\frac{1.8}{28.5} = .06$
Leverage	.06	
Strength	50 lbs.	

50 lbs. ÷ .06 = 791.14 lbs. = 359.6 K ÷ 23.35 = 15.40 K/cm.²

Summary of Data.—A summary of the computations is given in Table III. In all the muscle groups the men surpassed the women in computed strength per square centimeter. From the unweighted means it may be noted that the women possessed only about 78 percent of the strength that the men did. The percentage based on medians was still less, 73 percent. The greatest difference came from the strength of the triceps in which the women were only 60 percent as efficient as the men.

TABLE III

SUMMARY OF MUSCLE STRENGTH

Muscles	*Sex*	*Means*	*Medians*	*S. D.*	*Range*
Biceps,	M	9.83K	9.55K	1.64	7.23—13.96K
Brachialis,	F	7.65	7.55	1.32	5.62—10.10
Brachioradialis					
Triceps	M	14.76	15.17	2.44	10.17—17.94
	F	8.80	8.93	2.33	4.55—12.77
Leg flexors	M	7.84	7.50	2.15	4.23—11.75
	F	7.76	7.63	1.87	4.92—10.31
Vasti,	M	5.10	4.94	.59	4.22— 6.39
Rectus femoris	F	4.36	4.53	.70	2.86— 5.69
Unweighted	M	9.21	9.59	2.07	6.95—10.72
average	F	7.14	7.04	1.29	5.00— 9.07

LIMITATIONS OF THE STUDY

It was necessary to make several assumptions, as well as estimates, in this study. For example, in the testing of the muscle the joint was placed at right angles in order that the angle of pull of the muscle would be at right angles for the sake of maximum mechanical advantage. It was then assumed that the scores recorded represented the absolute strength of a given muscle group. Also, the proportional muscle sizes used in computing the muscle areas of the subjects were based on the two cadavers used by Morton (9) and Lambert (6). It was believed, however, that the averages are fairly accurate.

It is quite likely that many of the computations in this study are inaccurate because of the inability to measure directly. It is believed that the errors for the most part, nevertheless, have been cancelled in the average figures and that the results are of significance.

Questions are also raised as to the reasons for the high values obtained for the strength of the triceps in both sexes, and for the low values for the quadriceps femoris These may represent systematic errors in the procedure used, but, if so, the writer could not locate these errors.

Further studies may well be attempted to find the reason for the difference in strength between the sexes. Is the difference due to training on the part of the men, who are used to exerting maxi-

mum effort, or is it more a matter of physiological differences, such as glandular output?

The spread of values for the various individuals within their own sex suggests that further studies be projected to ascertain the reasons for this wide range of values.

SUMMARY AND IMPLICATIONS

1. From a group of college students the unweighted average of muscle strength was slightly above 9.2 K/cm.^{2} for men and 7.1 K/cm.^{2} for women.

2. The results of this research would indicate that with equal muscle cross section and leverage women possess roughly only 78 percent of the muscular strength of men.

3. In general, the average results would tend to uphold the findings of Fick, who assigned the value of 10 kilograms of force per square centimeter. It is probable that, if the subjects were trained and taught to put forth a maximum effort, the figures for men would be raised to this value.

4. From this study it is suggested that 10 kilograms be taken for the average figure for men, and 7.5 kilograms for women. It is felt that these figures may be used with considerable confidence. Certainly this study would cast strong doubts upon the values suggested by Recklinghausen (3.6 kilograms per square centimeter.)

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An Experiment in Teaching Tumbling With and Without Motion Pictures

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(Submitted for publication July, 1948)

THE past twenty years have witnessed a phenomenal increase in the use of moving pictures as an aid to teaching. Added stimulus was given to this trend during the last world war when the armed services made extensive use of this medium in their orientation and instructional programs. In athletics, where success and big gate receipts go hand in hand, it has been assumed and probably logically that moving pictures are of great aid in successful coaching. Consequently, each succeeding year has seen an increase in the batteries of cameras around the gridirons of the nation. As the costs of education continue to rise and the pressure to keep pace with the trends of the times weighs heavily on all school administrators, it is imperative that more studies be made to determine the role that the motion picture actually plays in the learning progress of students in academic and activity class work.

STATEMENT OF THE PROBLEM

This study* was undertaken in an attempt to measure the relative progress of tumbling classes taught with and without the use of moving pictures.

This study differed from most projects of this kind in that two media were employed in the use of motion pictures. In addition to showing members of the experimental group motion pictures of exemplary tumblers in action, movies were also made of the study group performing the more difficult tumbling events and these pictures were later screened before the group providing an opportunity for the students to see themselves in action.

PROCEDURE

The general plan of the study called for the selection of two classes in which tumbling was being taught with one used as a control and one as an experimental unit. Both classes were taught by the same instructor, with the total instructional time held constant, and, insofar as possible, the instructional units were identical. The variable consisted in the experimental class being shown pic-

* The study was financed by funds from the Carnegie Foundation Research Program.

tures of experienced tumblers executing selected stunts in correct form, the class later viewing pictures made of themselves performing the same activities. All filming and showing of pictures was done during the scheduled class period. In order to determine the equality of the two classes the Metheny Revision of the Johnson Test[1] was administered at the beginning of the study. Then at the end of the study, progress of the two groups was determined by performances in a ten-event battery of stunts.

Two freshman tumbling classes at Southern Methodist University were chosen for the study. There was no selection of students in enrolling for the classes. At the beginning of the study thirty-six men were enrolled in each class. The control class met at 9 A.M., and the experimental class as 10 A.M. three times weekly for seventeen class periods.[2] During the first class period the Metheny Revision of the Johnson Test was administered to both the control and experimental classes. The second through the fourth periods were devoted to orientation in tumbling and introduction to a number of stunts. The fifth class period was used for review of stunts presented to this point by the control class, while the experimental class met in the projection room and studied films which showed one experienced and several elementary tumblers performing the stunts that were being presented in this study. The film,[3] a 400 ft. 16 mm., silent reel, required fifteen minutes to project and was shown twice to the class.

Periods six through eight were used for identical instruction to the control and experimental classes. During period nine the control class practised on the mat stunts previously introduced, while in the experimental class partial slow motion movie shots[4] were made of the class members performing the following stunts: front chest roll, high backward roll, front chest roll from high backward roll, snap-up, head spring, and the cartwheel. Periods eleven and twelve were used for identical instruction to both classes. Period thirteen was used for review by the control class while the experimental group studied the moving pictures filmed in period nine and made notes of their errors and good points. The picture was shown twice with a number of shots being run back; errors and good points in the performances were pointed out by the instructor.

Periods thirteen through fifteen were used for review by both groups, with individuals devoting special time to the stunts in which

1 Eleanor Metheny. "Studies of the Johnson Test as a Test of Motor Educability," *Research Quarterly*, 9: 4 (December, 1938), page 105.

2 Seventeen periods were used because this was the time allotment for this activity in the freshman physical education program.

3 The film was made at Southern Methodist University for this study on 16 mm. at 32 and 48 frames per second.

4 24 and 32 frames per second.

they were especially weak. The last two days of the study were spent in testing—six stunts the first day and four the second. Two experienced judges were employed to score the performances of the members of the two classes. They used a subjective rating scale of 0 to 10 for each of the following events: low forward roll, low backward roll, front chest roll, head stand, dive over buck, high backward roll, cartwheel, front chest roll from high backward roll, head spring, and snap-up.

RESULTS OF STUDY

In an effort to get two balanced groups on which to base the results of the study, all students who had had previous tumbling experience or who failed to attend class regularly were dropped from the study. The control class had twenty students who were not eliminated by these criteria, while the experimental class had twenty-three. The scores made on the Metheny Revision of the Johnson Test were then used to match the twenty members of the control class with twenty of the twenty-three members of the experimental class. The results of this matching were as follows:

Control Class	*Experimental Class*
Mean = 21	Mean = 20.3
σ = 4.8	σ = 5.4
σm = 1.04	σm = 1.2

The critical ratio of .44 for the difference of the two means indicates that the slight difference between the two classes is probably due to chance; therefore, they may be considered comparable.

The subjective rating of the two judges on the ten-event battery of stunts had an r of .85 with a PE of .04 by the Pearson product moment method of correlation. This tends to indicate that their ratings were reasonably reliable. The final results of these test scores were as follows:

Control Class	*Experimental Class*
Mean = 125.9	Mean = 135.5
σ = 24.6	σ = 24.5
σ = 5.5	σm = 5.48

Although the scores of the experimental class were higher than those made by the control group, the critical ratio of 1.24 for the difference between the two means is not high enough to indicate a significant difference.

CONCLUSIONS

The brevity of the study as to subjects and class periods would make any prediction based on it somewhat hazardous. However, several things were indicated:

1. The experimental class made a little more progress than

did the control class as measured by the scores on the final battery of tests, but the superiority was not statistically significant.

2. There is a tendency for students to be highly motivated when moving pictures are made of the students in action and later screened for their viewing.

3. It is doubtful that extensive expenditures for moving pictures are warranted in the teaching of simple individual activities such as elementary tumbling unless the class is to extend through the entire semester. It is possible that the time devoted to the filming of class activities in this study could have been used to greater advantage in actual practice of the events included in the lessons.

4. Finally, there is a great need for more studies dealing with the use of motion pictures and the learning of motor skills.

Research Abstracts

By Granville B. Johnson
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ANATOMY

Gardner, Ernest. The innervation of the elbow joint. *Anat. Rec.*, 102:2 (October, 1948).

The gross and microscopic distribution of nerves to the human elbow joint was studied in dissections of adult joints and in serial sections of fetal joints. The articular nerves are derived from the musculocutaneous, median, ulnar, and radial nerves. Each nerve to the joint varies in gross distribution, but on entering the joint supplies a definite region. There is a certain amount of overlap with other nerves so that each major region is supplied by more than one nerve. Most of the nerve fibers probably supply blood vessels in the capsule and neighboring bone, but in the anterior region of the capsule, the region most subject to compression during movement, there are many small bundles of fibers which ramify in the fibrous layers of the joint capsule.

Gardner, Ernest. The innervation of the shoulder joint. *Anat. Rec.*, 102:1 (September, 1948).

The gross and microscopic distribution of nerves to the human shoulder joint was studied in dissections of adult joints, and in serial sections of fetal joints. The articular nerves are derived from the axillary, lateral anterior thoracic and suprascapular nerves, from the posterior cord, directly from the stellate and perhaps other sympathetic ganglia and possibly from the radial nerve. Most of the fibers probably supply blood vessels in the capsule and neighboring bone, but in the anteroinferior and anterosuperior regions of the joint there are many bundles of fibers which ramify in the fibrous layer. Each nerve to the joint varies in gross distribution, but upon entering the joint supplies a definite region. There is a certain amount of overlap with other nerves so that each region is supplied by more than one nerve.

Reynolds, Earle L., and Patricia Grote. Sex differences in the distribution of tissue components in the human leg from birth to maturity. *Anat. Rec.*, 102:1 (September, 1948).

A comparison is made of the distribution of tissue components in the male leg with a previous study on females. Measurements were made of breadth of muscle, bone, and fat (tela subcutanea plus skin) as seen in anteroposterior roentgenograms taken at 7 periods: birth (28 cases), 1 month (30), 1 year (30), 7.5 years (28), 12.5 years (27), 15.5 years (13), adult (31). Males are larger than females in mean breadth of muscle, bone, and total breadth of calf. Females are larger than males in mean fat breadth. Differences are marked at adolescence and in the adult. The adult female has a fat breadth in the leg twice as great on the average as the adult male, and slightly smaller than the year-old female. The adult male has a fat breadth in the leg less than half as great as the year-old male.

NUTRITION

Henderson, LaVell M., Bernard S. Schweigert, Alfred K. Mozingo, and Conrad A. Elvehjem. Reproduction and lactation of rats receiving pork diets. *J. Nutrition*, 36:4 (October, 1948).

Female rats fed rations containing pork as a source of protein mated normally, and gave birth to apparently normal young, but failed to rear them in some cases. The primary defect appeared to be in lactation. Whereas casein-fed rats usually reared an average of approximately two-thirds of the young and beef-fed rats, 80-90%, pork-fed animals reared less than one-

third of their young in certain experiments, indicating poor lactation. In other experiments the lactation was comparable to that obtained with rations containing beef.

When lactation failures were encountered with pork rations, increasing the B-vitamins had no effect, but fresh liver restored the lactation to that obtained when beef or casein was fed. The levels of B-vitamins commonly used in growth experiments were found inadequate for optimum reproduction and lactation performance with casein as the source of protein, especially when the fat level was high. Attempts to obtain a defatted pork preparation which would approach the beef or casein rations in supporting lactation were not successful.

Kuiken, K. A., and Carl M. Lyman, with the technical assistance of Shirley Dieterich, Marjory Bradford, and Mary Trant. Availablity of amino acids in some foods. *J. Nutrition*, 36:3 (September, 1948).

The extent to which the individual amino acids in a number of foodstuffs are available for use by the rat was studied by determining the 10 essential amino acids in the food and in the feces. Young rats were fed rations in which practically all of the protein was supplied (at a 10% level) by a single foodstuff. The experimental period was followed by a control period in which a ration containing 4% whole egg protein was fed. The data obtained from the control period were used to correct the apparent availabilities for the amino acids normally present in the feces as a result of metabolic processes and bacterial action.

The results showed that the individual amino acids in a given foodstuff are not always equally available. For example, the value obtained for the availability of arginine in cottonseed flour was 93.4% while the value for the availability of lysine in the same sample was 64.5%. In the case of meat all 10 amino acids were 100% available. The corresponding values for wheat ranged from 92.2 to 98.8% and for peanut flour from 94.8 to 99.5%.

Nataf, Berthe, Olaf Mickelsen, Ancel Keys, and William E. Petersen. The cholesterol content of cows' milk. *J. Nutrition*, 36:4 (October, 1948).

The levels of cholesterol and butterfat were determined in milk samples secured from Holstein, Jersey, and Guernsey cows over a 6-month period No ester cholesterol was present in any of the samples. The total cholesterol ranged from 6.7 to 16.0 mg per 100 ml. The level of cholesterol in the milk was a characteristic of the cow, particularly in the summer. There was a marked breed difference in the cholesterol content of the milk, especially during the winter. There was a slight difference in the cholesterol content of summer and winter milks, but the trends were in opposite directions when Holstein and Jersey milks were compared. There was a high degree of correlation between the butterfat and the cholesterol in the milk, but there was no relation between the cholesterol level in the blood and that in the milk.

Ruegamer, William R., William L. Brickson, Nancy J. Torbet, and Conrad A. Elvehjem. Response of dogs to liver extracts containing the pernicious anemia factor. *J. Nutrition*, 36:4 (October, 1948).

When growing dogs developed symptoms of blacktongue on a purified ration devoid of niacin, they were given single doses of niacin. This therapy was only partially successful and folic acid was found to play an important part in bringing about more consistent responses to niacin. Liver extracts known to be rich in the pernicious anemia factor were effective in restoring the blood picture of these animals, whereas folic acid had little or no effect. As little as 1 U.S.P. unit of activity per day was sufficient when injected intramuscularly. The factor does not appear to be stored in the animal organism to any great extent.

Salcedo, Juan, Jr., Eufronio O. Carrasco, Francisco R. Jose, and Ramon C. Valenzuela. Studies on beriberi in an endemic sub-tropical area. *J. Nutrition,* 36:5 (November, 1948).

A clinical survey of the incidence of beriberi in the Province of Bataan, Philippines, was undertaken in the latter half of 1947, in anticipation of the trial displacement of the ordinary white rice supply by fortified rice scheduled to occur in 1948. Bataan has a population between 90,000 and 100,000 and had a beriberi mortality rate in 1947 of 166.3 compared with 132 for the entire Philippines, where beriberi ranks second only to tuberculosis as a cause of death. About two-thirds of the deaths from beriberi are of infants. The survey comprised the clinical examination of 12,384 persons selected in a random manner from 9 of the 12 municipalities of the province, including the villages surrounding each. Fasting hour thiamine excretion in the urine was determined in 1,612 subjects, the majority of whom showed signs of beriberi. A total of 1,580 cases of beriberi of greater or less severity were encountered, of which 245 were classed as frank beriberi, 443, as suggestive beriberi, and 892, as doubtful. Total incidence was highest in expectant and nursing mothers, next highest in other adults in each of the classifications of beriberi. Frank beriberi was found in 1.99% of the population; some signs of beriberi were found in 12.76%. The inverse correlation of urinary excretion of thiamine with the incidence and severity of beriberi was poor.

Samuels, Leo T., Richard C. Gilmore, and Roger M. Reinecke. The effect of previous diet on the ability of animals to do work during subsequent fasting. *J. Nutrition,* 36:5 (November, 1948).

The present investigation was begun in order to determine the effect of a previous dietary regime on the ability of animals to withstand adverse conditions during subsequent fasting. Experiments were therefore set up in which the daily caloric intake of all groups of animals was maintained at the same level by forced feeding but was supplied largely by either carbohydrate, fat, or protein. In all groups sufficient protein was fed to maintain an adequate amino acid supply. The animals were placed in metabolism cages which also recorded activity. Voluntary activity and nitrogen balances were determined during the feeding period. Fasting was then begun and at intervals the amount of exercise required to produce complete exhaustion was determined. The animals were fasted until they died of either exhaustion or starvation. Animals previously on a fat diet survived longer during subsequent fasting and were able to do greater amounts of work before exhaustion during early fasting than when on an equicaloric high carbohydrate or high protein diet. Animals previously on a high carbohydrate diet were next best, and the protein-fed rats survived for the shortest period. Nitrogen excretion and blood sugar changes indicated that the fat-fed rats burned a different metabolic mixture during subsequent fasting than did those on a high carbohydrate diet, a smaller proportion of carbohydrate and protein being used.

Wissler, Robert W., Clyde H. Steffee, Laurence E. Frazier, Robert L. Woolridge, and Earl P. Benditt. Studies in amino acid utilization: III. The role of the indispensable amino acids in maintenance of the adult albino rat. *J. Nutrition,* 36:2 (August, 1948).

In this study the response of the normal adult rat to certain amino acid deficiencies was investigated. Sixty-three male albino rats, weighing 262 to 325 gm, and approximately 5 months old were used. In most experiments maintenance of weight and appetite was used to ascertain the dispensability of the missing amino acid. The normal rat maintained appetite and weight on rations in which only the 10 amino acids essential for growth were present. When arginine was removed, and if food consumption was maintained, weight and a positive nitrogen balance were preserved. The absence of each of

the remaining 9 essential amino acids from the basal ration always led to a weight loss and a negative nitrogen balance. Substitution of norleucine for leucine or lysine and tyrosine for phenylalanine led to a decreased appetite and weight loss similar to those produced by a deficiency of these amino acids. Despite the equalization of the nitrogen and caloric intakes via the forced feeding technique, the rats deficient in lysine, leucine, histidine and phenylalanine lost weight and were in negative nitrogen balance. The results indicate that the same 9 essential amino acids required for growth of the young rat are necessary for maintenance of appetite, weight, and nitrogen balance in the adult rat.

PHYSICAL ANTHROPOLOGY

Hertzberg, Hans T. E. Postwar anthropometry in the Air Force. *Am. J. Phys. Anthrop.* (ns), 6:3 (September, 1948).

Anthropometric research at Wright Field is being devoted specifically to Air Force aircraft engineering problems. Examples of these applications are presented and the methods of application are described. The various types of problems being investigated include dynamic studies of time and motion, and static studies of dimensional requirements of the human body under standard and non-standard conditions. A plea is made for a future academic requirement that anthropometric principles be made a part of the curriculum of engineering schools.

King, Barry G. Measurements of man for making machinery. *Am. J. Phys. Anthrop.* (ns), 6:3 (September, 1948).

Current aircraft are not made to fit the man. As a consequence, pilots are required to adapt themselves to existing conditions and operate under serious handicaps. Within the last few years this problem has received some attention but little quantitative work has been completed. The attention of physical anthropologists entering this field is invited to certain special requirements. These are concerned with (a) the relation of the usual postures assumed in operation of machine controls to those established as standardized, classical postures employed in anthropometry, and (b) the statistical treatment of the measurement data to insure adequate provision for a satisfactorily large part of the population. The anthropologist should further be advised of two popular fallacies which have adversely affected progress in this field. The first, which is mentioned only because it is so frequently encountered by those working in biotechnological fields, is the postulate that there are "natural movements" or "natural directions of movement" for the operation of machine controls. The second, which is related to the problem of statistical treatment of the data, is that design requirements should be based upon measurements of the "average man."

Lonie, Mansfield. Anthropometry and apparel. *Am. J. Phys. Anthrop.* (ns), 6:3 (September, 1948).

The talk cites examples of current use of anthropometric data in sizing items of apparel, explains how use of model forms has tended to lessen use of precise body-measurements, and indicates the variety of size measurements and how anthropometric data have been used to reduce this variety. It also indicates the anthropometric data needed to complete comprehensive sizing systems for apparel, urges cooperative research by scientists, applied mathematicians and apparel technologists, and suggests how needs of industry can be determined. It also stresses the practical value of body measurement data in sizing work, and concludes by urging continuous research to provide a large amount of practical data for the clothing industry, and the depositing of the resultant data in a central clearing agency.

Morant, Geoffrey M. Applied physical anthropology in Great Britain in recent years. *Am. J. Phys. Anthrop.* (ns), 6:3 (September, 1948).

A review of the applications of anthropometry to Royal Air Force problems during the recent war is presented. The method of application of anthropometry to the development of clothing size is described in detail and several points are noted which should serve as a guide in the conduct of applied research in physical anthropology. Emphasis is placed on the experimental method in obtaining the best results. As a matter of academic interest a problem investigated incidental to the general overall field is described. This problem involves the matter of the supposed increase in adult statures in British males. Evidence is offered that this supposed increase is a result of maturation of British males at progressively early ages throughout the past 100 years, with the most marked decrease in the maturation age having occurred between 1920 and 1945.

Randall, Francis E. Anthropometry in the Quartermaster Corps. *Am. J. Phys. Anthrop.* (ns), 6:3 (September, 1948).

A brief review of the past uses of anthropometry by the Army is offered and several examples of the types of information provided in the Quartermaster Corps are described. The organizational method by which the anthropometrist can best serve the needs of the Quartermaster Corps is described. The role of the anthropologist is one of mediation in that his primary duty, beyond collection of anthropometric data, is to organize them in such a manner that they may be utilized by equipment designers and, subsequently, by test agencies in the conduct of size tests of experimental equipment. The anthropologist benefits most in fulfilling his obligations by receiving current anthropometric data on new personnel especially in limited age groups. By use of current information, it is possible for the anthropologist to provide clothing tariffs for use in general procurement as well as in specific limited issues.

Stewart, Thomas D. Medico-legal aspects of the skeleton: I. Sex, age, race, and stature. *Am J. Phys. Anthrop.* (ns), 6:3 (September, 1948).

Owing to the proximity of the FBI Laboratory to the National Museum the staff of the Division of Physical Anthropology has been consulted frequently regarding the identification of skeletal remains found under suspicious circumstances. In broadly summarizing this experience, emphasis is placed upon the need in this type of work for extensive experience in handling human skeletal material and especially documented material. Care must be taken to distinguish between certainties and probabilities. Also there is danger of becoming over-confident because relatively few of the medico-legal identifications are verified. The emphasis is placed on caution because it is important to the science of physical anthropology, just as it is to the FBI, that our trained workers do not make mistakes. In connection with stature determinations it is pointed out that the available correlation tables and formulas still are based upon 100 or less French cadavers measured 60 years ago. The more extensive material available in this country needs to be worked up.

PHYSIOLOGY

Kral, J., and I. Schmid. Heart diseases and sport. *Casop. lek. cesk.*, 85:71-93 (1947).

Of 9,823 athletes examined, 63, or 0.65%, had valvular afflictions. Disease of the mitral valve was found in 27 men and 15 women, and aortic insufficiency in 13 men. Mitral disease was mostly valvular insufficiency. Twenty

of those afflicted took part in hockey, tennis, sprints, and competitive walking without difficulty. Four athletes with aortic insufficiency also took part in competitions; the others performed strenuous noncompetitive exercises without difficulty.

Schmid, I., and J. Kral. Exercise and recreation for cardiacs. *Casop. lek. cesk.*, 85:99-115 (1947)

No competitive sports should be allowed for people with valvular disease. Light exercises are not contraindicated in decompensation, if performed under supervision. The authors divided all sports into various categories according to their intensity for convenience of prescription.

Strait, L. A., V. T. Inman, and H. J. Ralston. Sample illustrations of physical principles selected from physiology and medicine. *Am. J. Physics*, 15:375-382 (1947).

Premedical and biology students who study physics will find this subject more useful if appropriate illustrations are drawn from physiology and medicine. Some examples: pressure, force, work, power, and efficiency illustrated by heart action; muscular mechanics by equilibrium of the body. For instance, it will be of great interest to a premedical student to find out through application of the laws of levers to the human spinal column that the pressure exerted upon the fifth lumbar vertebra in trunk bending may easily exceed 500 pounds, which explains the frequency of low back injuries. Study of the levers in the human body will clearly illustrate that we are built for speed, rather than for strength. This incidentally leads to avoidance of anatomical bulk.

Thompson, Ethel M., Elizabeth W. Cox, and Ada M. Ridgway. The basal metabolism of 218 girls and young women of Southern Arizona, 14 to 23 years of age, inclusive. *J. Nutrition*, 36:4 (October, 1948).

Calories per square meter per hour were calculated by 4 methods of evaluating individual tests: (1) average of results of all tests within 5% of one accepted as a base line on at least two mornings, (2) average of all tests, (3) first tests only, (4) average of tests in first mornings only. Smoothed yearly means in calories dropped sharply by all methods, this drop by the first method being from 36.40 to 31.21 for the years from 14 to 18, inclusive. Correlation with age was found to be highly significant statistically by the first two methods and less significant by the other two. When reducing the true yearly means to linear form it was found that, of the 4 methods of evaluating individual tests, the best straight line fit was obtained by means of the second method. Lumped means of 31.1 and 31.5 calories were taken for the first two methods, respectively, for the years 18 to 23, inclusive. This low-energy level would seem to indicate the appearance in women at this time of the zone of minimal metabolism.

Book Reviews

Gymnastic Handbook. J. G. Thulin. Lund, Sweden: South Swedish Gymnastic Institute, 1947. 472 pages. $5.50 in cloth binding, $4.50 in paper binding.

Gymnastik Atlas. J. G. Thulin. Lund, Sweden: South Swedish Gymnastic Institute, 1938. 372 pages, $3.50. Illus.

Few physical educators in the United States have in recent years taken the trouble to become informed of the details of physical education systems used in other countries. This is perhaps because of the fact that most of the publications of these other systems have been in a language other than English. Two publications on the Swedish system of physical education have recently come to hand which are worthy of note. Professor J. G. Thulin of the South Swedish Institute of Lund has written a gymnastic handbook, gymnastics with theory and methods, and has written it in English. This book is profusely illustrated, and the theory of modern, Swedish gymnastics is very thoroughly discussed. Every suggested exercise is illustrated in the margin. The kinesiology of the movement is also thoroughly discussed.

This textbook on Swedish gymnastics is supplemented by his *Gymnastik Atlas.* Here all of the movements are illustrated with photographs and the terminology is given in Swedish, German, French, and English. The handbook is a book of 472 pages, and the atlas is a volume of 386 pages. These books give one an exceedingly clear picture of the Swedish gymnastics of today. In view of the immense popularity of this system of physical education in Europe, England, and in all of Latin America, it would seem to the author that the physical educator in this country should at least be cognizant of the more recent developments in this system.

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Community Recreation. Harold D. Meyer and Charles K. Brightbill. Boston: D. C. Heath and Company, 1948. 689 pages, $5.00.

It is the opinion of the reviewer that this up-to-the-minute publication will not only achieve its selected purpose, as a guide to the organization and administration of community recreation, but will also take its well earned place across America in college and university training programs; in the in-service training programs of public and private recreation agencies; in the city and rural school district training programs. It is also felt that the contents of this volume will be most valuable in assisting volunteers who serve in capacities of leadership in program activities, on committees, and on recreation commissions and boards. It will be a "must" for immediate and constant reference in every library.

It is important to note that the text does not supplant any of the other standard references in recreation (Butler, Hjelte, Nash), but rather complements and supplements them. In short, a well planned perspective takes into account all valid writings to date by recommending further study and analysis by the reader in specific references. The book is not only a boon to the busy recreation worker because of its highly selected information and data, but because it paves the way for richer and better understanding of community recreation.

These "front-line" author-experts have achieved a remarkable familiarity and clarity of approach with the reader. One experiences an informal listening attitude as though the authors were discussing the information in the same room with the reader. The "What," "Why," and "How" of community recreation play important parts in the discussion. Further the reader finds himself wanting to read most, if not all, of the references recommended at the close of each chapter. This is perhaps due to the authors'

having created both interest and desire to do so by informally annotating each collateral resource. These references include discerning and pertinent books, articles, statements, and materials recently published on this important service to community living. An innovation entitled "The Workshop" lists many stimulating situations for exploration and for planning.

The book is divided into two parts, namely, "Foundations of Organized Recreation" and "Organization and Administration." These two divisions include some 39 chapters, each describing some important phase of the division named. The book is profusely illustrated with highly selected photographs, tables, and charts. A well organized appendix brings to the recreation leader a ready reference list of agencies and organizations active in recreation, recreation supply and equipment houses, addresses of publishers, and a list of films about recreation. Finally, a very functional index provides efficient guides for immediate access to the content of some 689 pages included in the volume.

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Index for Volume XIX (1948)

Cumulative Author, Subject Matter, and Title

Numbers refer to number of issue first and page number second. For example, 3:222 refers to October, page 222. Number 1 is March; number 2, May; number 3, October; number 4, December. No supplements to Volume XIX were published.

Action Current Study of Contraction-Movement Relationships in Golf Stroke. Arthur T. Slater-Hammel. 3:164.

Active Recreational Interests of Columbia College Alumni. L. Carroll Adams. 1:43.

ADAMS, L. Carroll. Active Recreational Interests of Columbia College Alumni. 1:43.

ALOIA, Alex D., and Laurence E. Morehouse. Change in Certification Requirements of Physical Education Teachers in 13 States Since 1942. 4:276.

ANDERSON, Theresa. The Use of the Motor Quotient in Assigning Relative Grades in Physical Education. 4:258.

ANTHROPOMETRY

Physique of Japanese Middle School Boys During the War Years, The. Harumi Matsuyama. 1:30.

Athletic Injuries Among Adolescents: Their Incidence and Type in Various Sports. J. Roswell Gallagher. 3:198.

ATHLETICS

Action Current Study of Contraction-Movement Relationships in Golf Stroke. Arthur T. Slater-Hammel. 3:164.

Athletic Injuries Among Adolescents: Their Incidence and Type in Various Sports. J. Roswell Gallagher. 3:198.

Effects of Physiological Age on Motor Achievement, The. John E. Nevers. 2:103.

An Experiment in Teaching Tumbling With and Without Motion Pictures. H. Steven Brown and Lloyd Messersmith. 4:303.

Motor Learning of Feeble-Minded Girls. D. K. Brace. 4:269.

Swimming Achievement Scale Scores for College Men. Jack E. Hewitt. 4:282.

The Use of the Motor Quotient in Assigning Relative Grades in Physical Education. Theresa Anderson. 4:258.

ATWELL, William O., and Edwin R. Albel. Reaction Time of Male High School Students in 14-17 Year Age Groups. 1:22.

BELL, Thomas B. The Validity of Certain Tests of Endurance. 3:229.

BENNETT, Bruce L. Contributions of Dr. Sargent to Physical Education. 2:77.

BOOK REVIEWS

4:314.

BROWN, H. Steven, and Lloyd Messersmith. An Experiment in Teaching Tumbling With and Without Motion Pictures. 4.303.

BRACE, D. K. Motor Learning of Feeble-Minded Girls. 4:269.

Change in Certification Requirements of Physical Education Teachers in 13 States Since 1942. Laurence E. Morehouse and Alex D. Aloia. 4:276.

CLARKE, H. Harrison. Objective Strength Tests of Affected Muscle Groups Involved in Orthopedic Disabilities. 2:118.

Contributions of Dr. Sargent to Physical Education. Bruce L. Bennett. 2:77.

DUFFY, William F. A Survey of Boxing Laws in the Forty-Eight States as Applied to High Schools. 1:34.

DUNPHY, E. B., A. E. Sloane, W. V. Emmons, and J. R. Gallagher. The Effect of a Single Group

Training Method Upon Myopia and Visual Acuity.
Effect of a Simple Group Training Method Upon Myopia and Visual Acuity, The. A. E. Sloane, E. B. Dunphy, W. V. Emmons, and J. R. Gallagher. 2:111.
Effect of the Regular Use of the Swimming Pool During the Winter Months on the Frequency and Severity of Cold Infections, The. Arthur Humphrey and William Ferinden. 1:40.
Effects of Physiological Age on Motor Achievement, The. John E. Nevers. 2:103.
ELBEL, Edwin R. The Relationship Between Pre-Exercise and Post-Exercise Pulse Rate. 3:222.
ELBEL, Edwin R., and William O. Atwell. Reaction Time of Male High School Students in 14-17 Year Age Groups. 1:22.
EMMONS, W. V., A. E. Sloane, E. B. Dunphy, and J. R. Gallagher. The Effect of a Simple Group Training Method Upon Myopia and Visual Acuity. 2:111.
ESPENSCHADE, Anna. Selection of Women Major Students in Physical Education. 2:70.
Establishment of Principles Which Are Essential for Realization of the Objectives of Physical Education, The. Hartley D. Price. 2:93.
Evaluation of Policies and Standards for Student Health Service Programs, An. Rhea H. Williams, 4:262.
Experiment in Teaching Tumbling With and Without Motion Pictures, An. H. Stevens Brown and Lloyd Messersmith. 4:304.
FERINDEN, William, and Arthur Humphrey. The Effect of the Regular Use of the Swimming Pool During the Winter Months on the Frequency and Severity of Cold Infections. 1:40.
GALLAGHER, J. Roswell. Athletic Injuries Among Adolescents: Their Incidence and Type in Various Sports. 3:198.
GALLAGHER, J. R., A. E. Sloane, E. B. Dunphy, and W. V. Emmons. The Effect of a Simple Group Training Method Upon Myopia and Visual Acuity. 2:111.
Graduate Minor in Physical Education, The. Lloyd M. Jones. 1:18.
HALLADAY, D. W. Marking in College Physical Education Activities. 3:178.

HEALTH, HEALTH EDUCATION, HYGIENE

Effect of the Regular Use of the Swimming Pool During the Winter Months on the Frequency and Severity of Cold Infections, The. Arthur Humphrey and William Ferinden. 1:40.
An Evaluation of Policies and Standards for Student Health Service Programs. Rhea H. Williams. 4:262.
HEWITT, Jack E. Swimming Achievement Scale Scores for College Men. 4:282.

HISTORY

Contributions of Dr. Sargent to Physical Education. Bruce L. Bennett. 2:77.
HUMPHREY, Arthur, and William Ferinden. The Effect of the Regular Use of the Swimming Pool During the Winter Months on the Frequency and Severity of Cold Infections. 1:40.
JONES, Lloyd M. The Graduate Minor in Physical Education. 1:18.
LARSON, Leonard A. A Note on Scaling Some Measures of Circulation and Respiration. 4:290.
Marking in College Physical Education Activities. D. W. Halladay. 3:178.
MASON, James G. Postwar Interests in Physical Education at the Ohio State University. 3:215.
MATSUYAMA, Harumi. The Physique of Japanese Middle School Boys During the War Years. 1:30.
Measurement of the Strength of Muscle Relative to the Cross Section, The Carrie Belle Morris. 4:295.
MESSERSMITH, Lloyd, and H.

Steven Brown. An Experiment in Teaching Tumbling With and Without Motion Pictures. 4:304.

MISCELLANEOUS

Personality and Attitude Differences Associated with the Elective Substitution of ROTC for the Physical Education Requirement in High School. Gaylord A. Nelson. 1:2.

Postwar Interests in Physical Education at the Ohio State University. James G. Mason. 3:215.

Survey of Boxing Laws in the Forty-Eight States As Applied to High Schools, A William F. Duffy. 1:34.

MOREHOUSE, Laurence E., and Alex D. Aloia. Change in Certification Requirements of Physical Education Teachers in 13 States Since 1942. 4:276.

MORRIS, Carrie Belle. The Measurement of the Strength of Muscle Relative to the Cross Section. 4:295.

Motor Learning of Feeble-Minded Girls. D. K. Brace. 4:269.

MUMFORD, Arnett W. The Present Status of Health and Physical Education Programs in Negro Senior Colleges. 3:190.

NELSON, Gaylord A. Personality and Attitude Differences Associated with the Elective Substitution of ROTC for the Physical Education Requirement in High School. 1:2.

NEVERS, John E. The Effects of Physiological Age on Motor Achievement. 2:103.

Note on Scaling Some Measures of Circulation and Respiration, A. Leonard A. Larson. 4:290.

Objective Strength Tests of Affected Muscle Groups Involved in Orthopedic Disabilities. H. Harrison Clarke. 2:118.

Personality and Attitude Differences Associated with the Elective Substitution of ROTC for the Physical Education Requirement in High School. Gaylord A. Nelson. 1:2.

Physical Efficiency Tests for College Women. M. Gladys Scott and Marjorie Wilson. 2:62.

PHYSIOLOGY

Effect of a Simple Group Training Method Upon Myopia and Visual Acuity, The. A. E. Sloane, E. B. Dunphy, W. V. Emmons, and J. R. Gallagher. 2:111.

The Measurement of the Strength of Muscle Relative to the Cross Section. 4:295.

A Note on Scaling Some Measures of Circulation and Respiration. Leonard A. Larson. 4:290.

Reaction Time of Male High School Students in 14-17 Year Age Groups. William O. Atwell and Edwin R. Elbel. 1:22.

Relationship Between Pre-Exercise and Post-Exercise Pulse Rate, The. Edwin R. Elbel. 3:222.

Physique of Japanese Middle School Boys During the War Years, The. Harumi Matsuyama. 1:30.

Postwar Interests in Physical Education at the Ohio State University. James G. Mason. 3:215.

Present Status of Health and Physical Education Programs in Negro Senior Colleges, The. Arnett W. Mumford. 3:190.

Present Status of Women's Physical Education in California Junior Colleges. Mildred D. Wollet. 3:185.

PRICE, Hartley D. The Establishment of Principles Which Are Essential for the Realization of the Objectives of Physical Education. 2:93.

PROFESSIONAL EDUCATION

Change in Certification Requirements of Physical Education Teachers in 13 States Since 1942. Laurence E. Morehouse and Alex D. Aloia. 4:276.

Selection of Women Major Students in Physical Education. Anna Espenschade. 2:70.

PROGRAM

Establishment of Principles Which Are Essential for the Realization of the Objectives of Physical

Education, The. Hartley D. Price. 2:93.
Graduate Minor in Physical Education, The. Lloyd M. Jones. 1:18.
Marking in College Physical Education Activities. D. W. Halladay. 3:178.
Present Status of Health and Physical Education Programs in Negro Senior Colleges, The. Arnett W. Mumford. 3:190.
Present Status of Women's Physical Education in California Junior Colleges. Mildred D. Wollet. 3:185.
Reaction Time of Male High School Students in 14-17 Year Age Groups. William O. Atwell and Edwin R. Elbel. 1:22.

RECREATION

Active Recreational Interests of Columbia College Alumni. L. Carroll Adams. 1:43.
Relationship Between Pre-Exercise and Post-Exercise Pulse Rate, The. Edwin R. Elbel. 3:222.

RESEARCH ABSTRACTS

1:48, 2:148, 3:243, 4:308.
SCOTT, M. Gladys, and Marjorie Wilson. Physical Efficiency Tests for College Women. 2:62.
Selection of Women Major Students in Physical Education. Anna Espenschade. 2:70.
SLATER-HAMMEL, Arthur T. Action Current Study of Contraction-Movement Relationships in Golf Stroke. 3:164.
SLOANE, A. E., E. B. Dunphy, W. V. Emmons, and J. R. Gallagher. The Effect of a Simple Group Training Method Upon Myopia and Visual Acuity. 2:111.
Survey of Boxing Laws in the Forty-Eight States As Applied to High Schools, A. William F. Duffy. 1:34.
Swimming Achievement Scale Scores for College Men. Jack E. Hewitt. 4:282.

TESTING

Objective Strength Tests of Affected Muscle Groups Involved in Orthopedic Disabilities. H. Harrison Clarke. 2:118.
Physical Efficiency Tests for College Women. M. Gladys Scott and Marjorie Wilson. 2:62.
Validity of Certain Tests of Endurance, The. Thomas B. Bell. 3:229.
Use of the Motor Quotient in Assigning Relative Grades in Physical Education, The. Theresa Anderson. 4:258.
Validity of Certain Tests of Endurance, The. Thomas B. Bell. 3:229.
WILLIAMS, Rhea H. An Evaluation of Policies and Standards for Student Health Service Programs. 4:262.
WILSON, Marjorie, and M. Gladys Scott. Physical Efficiency Tests for College Women. 2:62.
WOLLET, Mildred D. Present Status of Women's Physical Education in California Junior Colleges. 3:185.

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The following policies should be observed in the preparation of manuscripts for publication in the Quarterly:

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Since three members of the Board of Associate Editors review an article it is requested that at least two copies of the manuscript (the original and a clear carbon) be submitted in order to facilitate reviewing. The carbon copy will be returned to the author for checking against galley proofs. Manuscripts should be double spaced.

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Ogden, Jean, and Jess Ogden. *Small Communities in Action*. New York City: Harper & Brothers, 1946. (books)

Deaver, G. G. Exercise and heart disease. *Research Quarterly*, 10:24-34, 1939. (periodicals)

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While *Quarterly* style is preferred a modification of it may be used if the essential information is given.

Illustrations.—Charts, graphs, etc., are required in many instances. Only figures which aid in clarifying the article should be included. Authors are required to pay the excess if total illustration costs exceed $25.00. Figures (and tables) should be prepared with the size of the *Quarterly* page (4⅛x7 inches) in mind, with the idea of conserving vertical space. Photographs and shaded figures are expensive to reproduce; if used they should be on glossy paper and of the size desired in reproduction.

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Reviews.—Normally book reviews and research reviews will be prepared at the request of the Editor; nevertheless, reviews may be submitted by others and their acceptability will be judged according to usual editorial procedures. Contributors planning such reviews should correspond with the Editor.

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(1938 to date)

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1938

Q 213 A Study of Falls in Skiing. Smart.

1939

Q 227 The C.C.C. as a Builder of Physical Fitness in Youth. Walker.

Q 241 An Experiment in Self-Directed Study for College Freshmen. Guernsey.

1940

Q 249 Prediction of Time in Swimming Based on Oxygen Consumption. Karpovich and LeMaistre.

Q 252 Prediction of the Advent of the Menarche from Height and Weight. Shuttleworth.

1941

Q 262 Intramural Athletics for Men in Negro Colleges. Taylor.

Q 267 Coefficient Performance Chart. Jefferson.

Q 270 Anthropometric Study of Negro and White Women. Steggerda and Petty.

Q 288 The Factor Analysis as a Research Technique. McCloy.

Q 289 The Status of Student Health Programs in Negro Colleges. Cornely.

Q 306 A Fifty-nine Year Survey at Yale Reveals Freshmen are Becoming Younger, Heavier, and Taller. Deegan.

1943

Q 342 Determination of the Weight and Size of a Standard Discus for College Women. Tuttle.

Q 347 Yale University Completes One Year of Its Wartime Physical Training Program. Wickens and Murphy.

Q 352 Achievement Scale Scores for Wartime Swimming. Hewitt.

1946

Q 391 The Effect Upon Pulse Rate of Various Cadences in the Step-Up Test. Miller and Elbel.

1947

Q 400 Components of Variation and the Consistency of Repeated Measurements. Brozek and Alexander.

Q 404 Sexual Maturing of Girls as Related to Growth in Strength. Jones.

Q 405 Some Aspects of the Role of Games, Sports, and Recreational Activities in the Culture of Modern Primitive Peoples. Stumpf and Cozens.

Q 406 An Analysis of Relationships Existent Between Health Practice, Adjustment, and Physical Performance of Freshmen Women. Powell.

Q 407 Achievement Scales in Six Physical Education Activities for Secondary School Boys. Knapp.

Q 408 Tobacco Smoking, Strength, and Muscular Endurance. Willgoose.

Q 409 A Comparative Study of Structure and Function of Normal, Pronated, and Painful Feet Among Children. Kelly.

Q 410 The Development of a Beam-Walking Test and Its Use in Measuring Development of Balance in Children. Seashore.

1948

Q 411 Personality and Attitude Differences Associated with the Elective Substitution of ROTC for the Physical Education Requirement in High School. Nelson.

Q 412 Reaction Time of Male High School Students in 14-17 Year Age Groups. Atwell and Elbel.

Q 413 The Physique of Japanese Middle School Boys During the War Years. Matsuyama.

Q 414 The Effect of a Simple Group Training Method Upon Myopia and Visual Acuity. Sloane, Dunphy, Emmons, and Gallagher.

Q 415 Physical Efficiency Tests for College Women. Scott and Wilson.

Q 417 Objective Strength Tests of Affected Muscle Groups Involved in Orthopedic Disabilities. Clarke.

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Erratum

In the October issue of the Quarterly pages 210 and 212 in Dr. Gallagher's article entitled "Athletic Injuries Among Adolescents: Their Incidence and Type in Various Sports" were reversed with the result that Tables V and VI do not read in the correct order. Page 210 should be 212 and vice versa. We are extremely sorry for this error which occurred when setting the type in page form.